ELECTRIC MOBILITY TRANSITION & LOCALISATION

Towards Unlocking the NEV Value Chain for Africa

STRATEGY AND INVESTMENT REPORT



AIH GROUP

IDC
Industrial Development Corporation

September 2024

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1. EXECUTIVE SUMMARY

This report aims to capture the growth of the NEV market to underpin the development of industry strategies and catalyse the provision of substantial funding to support the development of an NEV ecosystem in South Africa and Africa.

The previous work has considered the entire NEV ecosystem in the Situational Analysis Report, as well as the inputs from the Stakeholder Engagement Report and Economic Model to describe the NEV landscape in Africa and South Africa over the next twenty years.

This report identifies Four Pillars that form the basis for the localisation strategy. These four pillars and value chains are: 1) electric L-Class electric vehicles, 2) NEV charging infrastructure, 3) battery manufacturing and battery pack assembly, 4) battery recycling. For each of the four pillars to identify, a value chain is mapped to identify investment opportunities that are specifically tailored to the South African and the African NEV environment.

This report takes a closer look at the light vehicle class (L-Class) in more detail, which includes two-, three- and four-wheeled vehicles. Collectively, these are also referred to as "micro-mobility".

Section A below looks at the stages required to localise NEV ecosystems in South Africa and takes a five-step approach to identifying and assessing the opportunities identified. Section B provides an overview of the customised economic model and forecast used to validate the selection and provide an indication of the market size, value and timing. Section C provides a conclusion and outlook for the future.

A. Report Phases

The process to identify and evaluate NEV opportunities was conducted in a series of structured phases as follows:

1. Strategy to create an NEV environment: An enabling environment for NEV will ensure a strategy that leads to an investment value chain, the localisation of components, and an improved automotive economy. South Africa can prepare for this through 1) Government action in the form of policy, incentives, and funding 2) International and local partnerships for knowledge transfer and skills development in South Africa.

2. NEV opportunity identification: The objective of this section was to identify and prioritise components of these NEVs that have the potential for competitive production in South Africa. To achieve this, a systematic approach utilising a selection strategy and scoring matrix system was used to assess the capabilities and gaps within South Africa's manufacturing landscape, pinpointing opportunities for investment across the NEV value chains. The four value chains analkysed are 1) electric L-Class electric vehicles, 2) NEV charging infrastructure, 3) battery manufacturing and battery pack assembly, 4) battery recycling. Together these four interlinked value chains are driving the development of the NEV industry in Africa and South Africa, shaping a future of sustainable mobility and environmental stewardship. A high-level opportunity scoring matrix presented a strategy to identify key components to be localised within the four value chains first, which supported the four value chains above. The L-Class vehicle components that scored highest in the matrix are: tyres, steel frame, and wiring harnesses and battery packs. These components are seen as prime candidates for localisation in South Africa.

3. NEV opportunity feasibility scoping: In this section, the identified opportunities were quantified to assess the ability to achieve economies of scale. An assessment of the demand for ICE motorbikes was undertaken and then a review of imported electric two-wheelers, which revealed that a ready market for electric two-wheelers exists, with South Africa capable of becoming a high-tech manufacturing base for the complete package of components (CKD kits) for export and manufacture in other African countries. Assessment of market trends in Africa and South Africa shows that the South African two-wheeler market is showing strong growth, supported by the growth of the delivery market segment. Comprehensive market demand modelling shows that the electric two-wheeler market could grow to around 50% of the total two-wheeler market by 2034 and could

exceed 1.1 million units per year by 2040. A key point was the relative shortage of experts to service electric motorbikes and the higher frequency of new parts requiring servicing, particularly batteries at 32% of all repairs. Demand in the battery market was assessed based on prevailing usage trends and a usage trend to estimate the number of batteries in circulation and the market opportunity. There are numerous challenges that need to be overcome to drive the electric two-wheeler market in Africa: The difficult African terrain leads to significant wear and tear on vehicles, charging infrastructure needs to be reliable and dense, high quality batteries need to be made available to low volume African buyers and there is a significant lack of expertise in this particular area. This section concludes that there is a large market opportunity for electric two-wheelers, but that key international partnerships need to be forged for the various support pillars to shorten the time to market.

4. NEV investment opportunities: The emergence of electric mobility solutions has contributed to the creation of numerous new companies in Africa and South Africa that support NEV's common goal: scaling its electric mobility solutions in Africa. This report identifies the typical investment opportunities that could arise from local manufacturing or assembly of L-Class electric vehicles in Africa, charging infrastructure, battery pack assembly and battery recycling. This report shares these observations with the intention of illustrating the dynamic business and investment opportunities for private sector investors, donors, development finance institutions (DFIs), commercial lenders and policy makers alike. Further exploration of these business opportunities could help unlock new value chains that are uniquely suited to address the industrial development of African mobility, creating new employment opportunities while combating pollution from traditional ICE modalities.

5. Green/Sustainable Manufacturing and Special Economic Zones (SEZs): In South Africa, SEZs were developed as economic instruments to attract foreign and domestic investment and promote export-orientated industries. Looking at the four pillars of focus and after reviewing all eleven SEZs in South Africa, it was determined that the Atlantis SEZ, the Coega SEZ, the East London Industrial Development Zone (ELIDZ) and the Dube Tradeport SEZ are best suited for the manufacturing and assembly of vehicles and batteries, with the addition of the Tshwane Automotive SEZ for the assembly and recycling of batteries. Each SEZ and IDZ was traversed and the market opportunities for each highlighted.

B. Economic Model and Market Demand

The identified NEV market opportunities were subjected to a rigorous economic modelling process to underpin the market demand assumptions as follows:

1. Macro-Economic Modelling: To support the identified investment opportunities a macroeconomic model was developed that takes into account a number of key inputs such as current vehicle categories and numbers, manufacturing and operating costs, a range of transition scenarios from ICE to NEV, and a localisation scenario. Credible institutions such as NAAMSA, current South African OEMs and a number of representative industry stakeholders were consulted, and these inputs were incorporated into a twenty-five-year economic model from 2025 to 2050. The key outputs were projections for Gross Domestic Product (GDP) supported by the NEVs and battery production employment supported by the production of NEVs and batteries, and CO_2 emissions avoided by the transition from ICEs to NEVs.

2. NEV Sector Economic Modelling: Based on the comprehensive analysis of investment opportunities outlined above and in the context of the macroeconomic model developed, a series of sector-specific market feasibility calculations up to 2040 were carried out based on the GDP and GDP per capita of a given African country, current unit vehicle prices and an expected compound annual growth rate (CAGR) for the vehicle sector. This economic modelling process resulted in a current and a future unit value for the market segment as well as a current and a future market value for a sector with an average unit price per unit in that sector. The sectors considered on this basis are the forecast demand for ICE motorbikes for Africa, the forecast market demand for electric motorbikes for Africa and the market estimate for L-Class vehicles for South Africa, the volume of the L-Class 'Value Chain' for South Africa.

3. NEV Sector Motorcycle Modelling: Based on the findings and data collected for the study, a more detailed analysis of the ICE and e-bike motorbike market for Africa has been provided in the tables appended to this report. The market for ICE and electric two-wheelers has been estimated as follows:

ICE Two-Wheeler Market Assessment:

African Countries	13 Surveyed	51 Extrapolated
Units in 2022	902,583	1,412,928
Units in 2040 (7% CAGR)	1,993,336	2,627,373
Market potential in 2040	USD 5,261 million	USD 6,935 million

Electric Two-Wheeler Market Assessment

African Countries	13 Surveyed	51 Extrapolated
Units in 2022	10,705	13,300
Units in 2040 (30% CAGR)	848,729	1,118,687
Market potential in 2040	USD 3,027 million	USD 3,990 million

C. Conclusions and Next Steps

To summarise, this report has set out a clear strategy for building a sustainable ecosystem for New Energy Vehicles (NEV) in South Africa. The report identifies four key pillars that form the foundation of the localisation strategy: L-Class electric vehicles, NEV charging infrastructure, battery manufacturing/battery pack assembly and battery recycling.

This report develops an investment strategy and localisation approach designed to support the development of electric micromobility value chains in Africa. Considering the four pillars together is critical to ensuring a sustainable NEV ecosystem. The aim is for the NEV ecosystem to support a circular economy and for it to enable South Africa to become the NEV technology centre for Africa.

It can be concluded that a step-by-step approach should be adopted for the localisation of an NEV ecosystem in South Africa and Africa, with the process outlined in the following report.

2. INTRODUCTION

This section provides the context for the New Energy Vehicle (NEV) Value Chain project, including an overview of the project and its scope

2.1 NEV Value Chain Project Context

The value chain assessment process began with a comprehensive Situational Analysis of potential industries and components, taking into account the industry's resources, infrastructure and availability. Key stakeholders and industry leaders were identified, which in turn supported the exploration of numerous industry opportunities. The objective was to gain insight into the existing status of the industry and to determine the interest of industry players in entering the NEV and the automotive sector and supply chain. In conjunction with this report, an Economic Model was also developed to understand the economic impact of the transition to NEVs in South Africa.

2.2 Report Purpose and Scope

The purpose of the Strategy and Investment Report is to show how a sustainable ecosystem for NEVs can be created at the local level for specific use cases. This report aims to capture the NEV market potential and identify the opportunities for investment to support the development of a NEV ecosystem.

To achieve this goal, the entire NEV ecosystem is considered in the Situation Analysis Report, as well as the input from the Stakeholder Engagement Report and the Economic Model. This report identifies four pillars that form the basis for the localisation strategy. The four pillars are: L-Class Electric Vehicles, NEV Charging Infrastructure, Battery Manufacturing/Battery Pack Assembly, Battery Recycling, as shown in Figure 1 below. This report focuses on the light vehicle class (L-Class), which includes two-, three- and four-wheeled vehicles, and four- wheelers. Collectively these vehicles are also referred to as "micro-mobility".

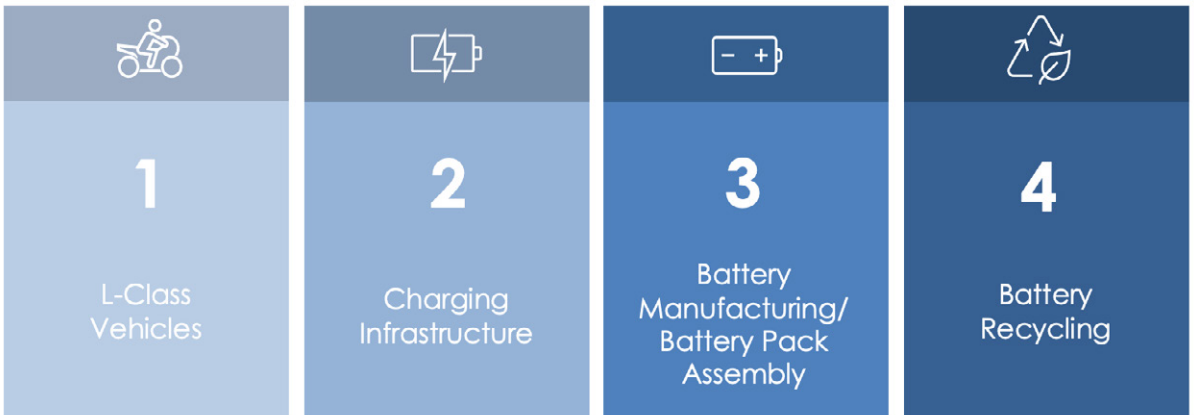


Figure 1: Four Pillars of the Localisation Strategy

For each of the four pillars, a value chain is mapped to identify investment opportunities that are specifically tailored to the IDC and the South African NEV environment. To begin the localisation process, the most feasible and likely opportunities from the four value chains are first targeted. The high-level scoping of the identified opportunities and the market attractiveness are presented in a scenario for South Africa and the rest of Africa.

2.3 Approach

This report proposes a phased approached for the localisation of a NEV ecosystem in South Africa.

PHASE 1: ESTABLISH NEV ENVIRONMENT

First and foremost, South Africa must create an environment that supports the successful implementation and development of a sustainable NEV value chain. Phase 1 will set the course for the localisation of NEVs in South Africa. This phase includes:

- Description of the market environment of the four pillars to provide background information and context for each pillar. It is important to understand each of these pillars independently before considering them as a single integrated NEV ecosystem. The pillars were analysed in detail in the situation analysis report.
- The need for government to step in and enable South Africa through appropriate policies to promote NEVs and the green transition. A shared vision for NEVs in Africa and South Africa enables engagement and collaboration to ensure knowledge sharing and skills transfer.
- Engagement with potential local and international partners to better understand the NEV environment. This part of the NEV value chain localisation project is covered in detail in the Stakeholder Engagement Report.

PHASE 2: LOCALISATION

The strategy and investment report focuses mainly on this phase. To initiate the localisation process, phase 2:

- A value chain is mapped for each of the four pillars to identify investment opportunities specific to the IDC and NEV environment in South Africa.
- Evaluation matrix to make a costed selection of L-Class electric vehicle components that can be manufactured in South Africa.
- Identification of current market demand and projection of future market demand to determine the feasibility of the identified opportunities.
- Investment at a high level with the possibility of industrialisation and localisation.

PHASE 3: NEV ECO-SYSTEM

The way forward to achieve a functioning and self-sustaining NEV ecosystem in South Africa. The development of the L-Class NEV ecosystem lays the foundation for expansion to other NEV value chains in South Africa. Phase 3 describes:

Case studies of successful L-Class electric vehicle ecosystems in Africa. These case studies represent potential investment opportunities as well as learning opportunities from which valuable information on financially viable business models can be gained.

A brief strategy to integrate the NEV ecosystem with green/sustainable manufacturing and special economic zones in South Africa.

The aim is for the NEV ecosystem to support a circular economy and for it to enable South Africa to become the NEV technology centre for Africa. Considering the four pillars together is critical to ensuring a sustainable NEV ecosystem.

3. THE L-CLASS VEHICLE PILLAR

This section of the report sets out the background and market environment for L-class electric vehicles in Africa and South Africa. This light vehicle class (L-Class) includes two-, three and four- wheeled vehicles. Together these vehicles are also referred to as "micro-mobility".

3.1 Overview

Over the last 30 years, the affordability of two- and three-wheelers has boosted mobility and economic development in many low- and middle-income countries by shortening journey times at a much lower cost than private vehicles. ICE motorbikes are therefore widely used in Africa, Latin America and Asia. The electric two- and three-wheelers are primarily built to provide an environmentally friendly and cost-effective (total cost of ownership) alternative that is gaining traction, albeit slowly.

Developments in ICE two- and three-wheelers are aimed at extending the service life of these modes of transport. In the case of two- and three-wheelers with internal combustion engines, there has been a development from highly polluting and less efficient two-stroke engines to four-stroke engines, which are less harmful to the environment.

Over the last two decades, the number of motorbikes, both two- and three-wheelers, has increased rapidly in sub-Saharan Africa. This growth has been made possible by the availability of inexpensive motorbikes from China and India and, above all, by the commercial use of motorbikes, e.g. as passenger taxis and for the delivery of goods over the last mile.

The acceptance of motorbikes in Africa is mainly driven by commercial motorbike taxi services, which have been rapidly adopted in countries with high population density and low income.

In Africa, motorbikes have found a niche application as a means of livelihood, mainly due to the poor transport and road infrastructure in African countries. In rural areas, they are valued for their robustness and flexibility, as they can negotiate heavily potholed roads, steep mountain paths and muddy tracks that are inaccessible to four-wheeled vehicles. In urban areas, they have the upper hand in congested areas where they are the only means of motorised transport that can consistently navigate through traffic jams and get passengers to their destinations on time.

Commercial motorbikes have created millions of jobs for motorcyclists. In countries where most employment opportunities are in the informal sector with low wages and poor working conditions, motorcycling can offer a relatively lucrative and attractive livelihood with low barriers to entry. Many motorcyclists are self-employed and work in the informal economy. Ownership is acquired through rental (weekly or daily fee), hire purchase or cash. A small but growing number of commercial motorbike jobs are formal or semi-formal, such as ride-hailing apps or delivery services for urban deliveries and rural shop replenishment.

Motorbikes are also used by utility companies, the healthcare sector and other service providers. They are relatively inexpensive and are ideal for one-person operations. In areas where road quality is poor, they can provide communities with access to vital services such as vaccines, health screenings, emergency transport and more.

In 2022, the number of registered motorbikes in Africa was estimated at 27 million, up from less than 5 million in 2010. Imports of motorbikes to Africa will reach 1.4 million units worth $2.41 billion in 2022, representing 6.4% of global motorbike imports. Motorbikes are most popular in the countries of West and East Africa, with Nigeria (25% of the African fleet), Burkina Faso, Kenya, Tanzania and Uganda accounting for almost half of registered motorbikes.

There are significant differences in motorbike density across Africa, with high penetration in West Africa and slightly lower in East Africa. In contrast, the density in Southern Africa is very low, with the exception of Angola and Mozambique.

The map below shows the estimated number of motorbikes per 1 000 inhabitants in each African country in 2020, with Burkina Faso having the highest density, estimated at over 100 motorbikes per 1 000 inhabitants.

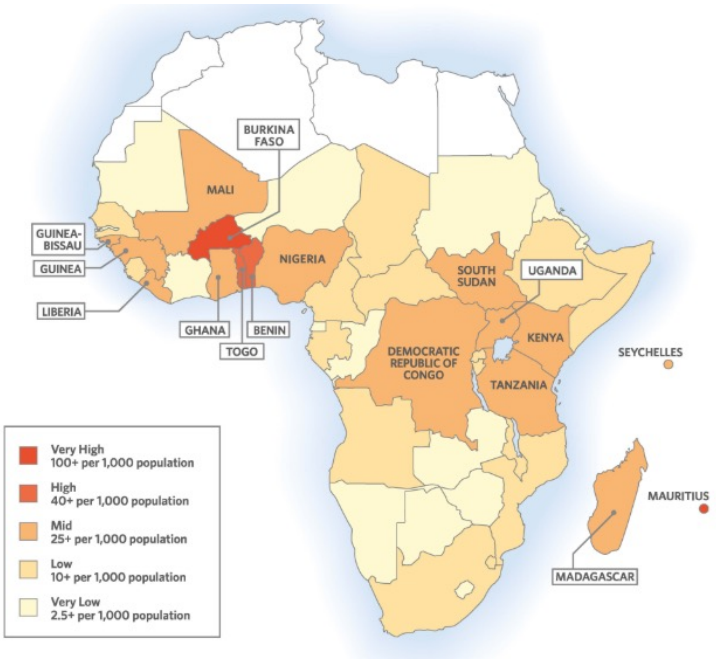


Figure 2: Estimated number of motorcycles per 1,000 of the population, 2020[1]

The growth in demand for motorcycles is projected to continue in the coming years, or even accelerate, with increased private ownership - as has been seen in Asia. Various studies project CAGR of between 3% and 5% up to 2030 for ICE motorcycles.

The number of registered motorcycles in South Africa stood at approximately 360 000 in January 2024[2], with 32 000 sales of new motorcycles in 2023. The commercial segment of the market is on an upward trajectory with 10% growth in the first half of 2023[3] and electric motorcycles showing a sharp increase as appetite for electric derivatives among commercial fleet owners is growing.

3.2 Two-Wheeler Environment

Two-wheelers are shown to be more susceptible to electrification as evidenced by the EV penetration of two-wheelers in China. By 2015 China already had 200-230 million electric two wheelers on its roads.[4] Penetration is much lower in other major motorcycle markets such as India, Indonesia and Vietnam but is growing rapidly from a low base, especially in India.[5] EV two-wheeler penetration in India for March 2024 stood at 8,9% vs 5,7% in February 2024 according to an analysis report by Elara Capital.[6]

Although Africa represents a remarkable 6.3%[7] of global motorcycle imports, the electric two-wheeler market in Africa is still in its infancy. It is, however, projected to witness a strong CAGR of 24.78% during the forecast period 2024-2031, growing from USD 554.68 million in 2023 to USD 2612.14 million in 2031.[8]

1 Wheels Of Change. 2020. The Wheels of Change: Safe and Sustainable Motorcycles for Sub-Saharan Africa - Amend
2 eNatis 2024
3 https://www.timeslive.co.za/motoring/news/2023-08-21-mzansis-motorcycle-sales-get-a-boost-from-e-commerce/
4 Electric mobility and the quest for automobile industry upgrading in China (idos-research.de)
5 Black et al., Electric two wheelers in Africa: Markets, Production and Policy PRISM-WorkingPaper%202019-1.pdf (uct.ac.za)
6 Moneycontrol News. 2024. https://www.moneycontrol.com/news/technology/electric-two-wheeler-sales-rise-30-in-fy24-to-9-42-lakh-units-12556391.html
7 Trade Map - Trade statistics for international business development
8 https://www.giiresearch.com/report/mx1453697-africa-electric-two-wheeler-market-assessment-by.html

In Africa, an estimated 75% of all motorcycles are motor-cycle taxis, with approximately 5% of motorcycles being used for deliveries and the remaining 20% for private use. The diagram below illustrates the main uses of motorcycles in selected African countries.

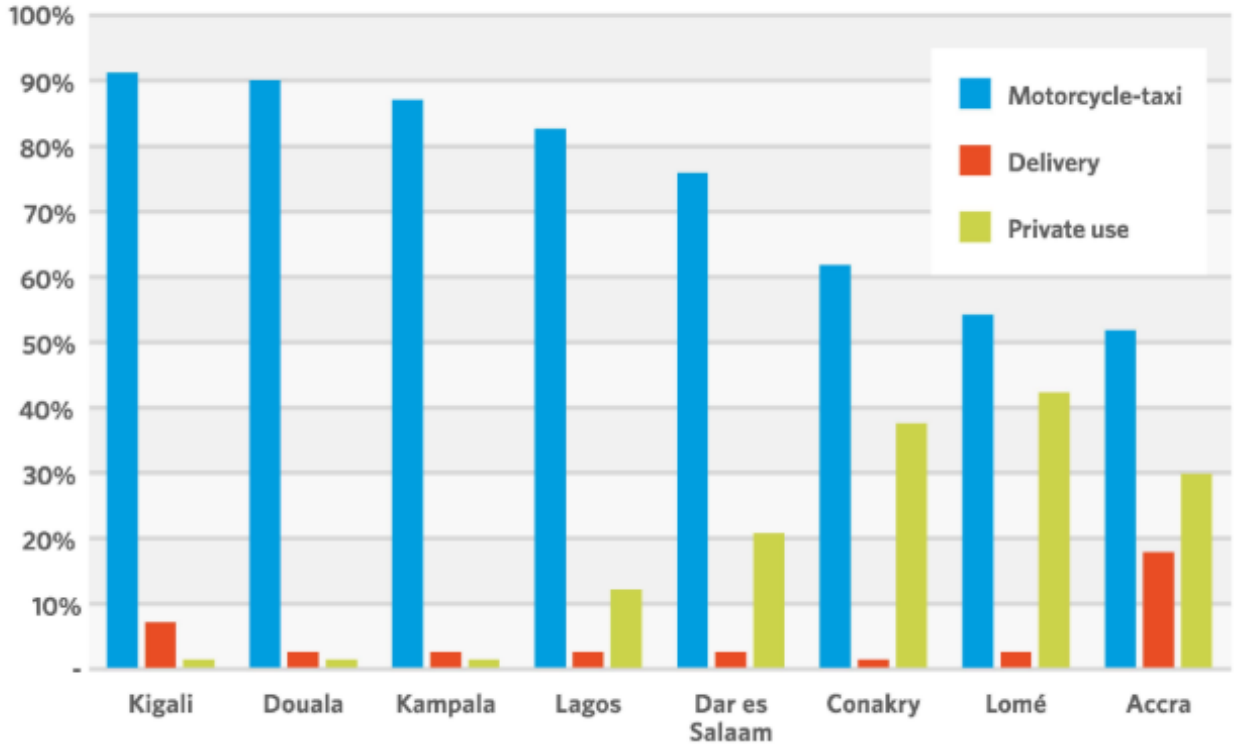


Figure 3: Types of Use of Motorcycles in Selected African Countries9

The popularity of motorbikes in Africa is confirmed by a study carried out on rural roads in Tanzania in 2015. According to the study, 90% of all motorised vehicles were motorbikes, and 52% of these motorbikes carried more than two people.

3.3 Three-Wheeler Environment

Africa electric three-wheeler market is anticipated to grow at a CAGR of 12.54% during the forecast period between 2023 and 2030. [10,11] Dominated by the Asia Pacific region, the global electric three-wheeler market size was valued at USD 751.94 million in 2021 and will register a CAGR of 8.23% during the forecast period till 2030.

The demand for electric three wheelers is rapidly increasing in many African countries, which is boosting imports and sales. The three-wheelers in Asia-Pacific and Africa market was valued at $3.05 billion in 2021, and is expected to reach $5.58 billion by 2031, growing at a CAGR of 6.5% from 2022 to 2031.

Three wheelers are ideal for the delivery of medium-sized goods that are larger in size and volume. A good local example of this is MellowVan, which is targeting a production of 30-40 vehicles per month in the near future.

Three wheelers have many different local names, including *bajaji* in Tanzania, *yellow-yellow* in Ghana, and *keke napep* in Nigeria. They are more common in the coastal regions of East Africa and Sahelian West Africa. In general, they are more common in cities and towns with flatter landscapes. This is partly because their low

9 Wheels Of Change. 2020. The Wheels of Change: Safe and Sustainable Motorcycles for Sub-Saharan Africa - Amend
10 https://www.marketsandata.com/industry-reports/africa-electric-three-wheeler-market
11 https://www.alliedmarketresearch.com/asia-pacific-and-africa-three-wheeler-market-A31692

ground clearance makes them less suitable for unpaved road, as well as their relatively small engines (around 200cc) and heavy payloads. *Tuktuks* provide two common types of passenger services in African cities: on-demand door-to door and shared main roads. In some places, they have overtaken minibuses. In some cities, such as Dar es Salaam, attempts have been made to displace motorbike-taxis in favour of tuktuks, as tuktuks are considered safer than motorcycles.

In terms of transport services, passenger tuktuks are flexible and range from a commercial door-to-door ride-hailing service to a route-based service, sometimes offering both on the same trips.

There are a wide variety of cargo tuktuks, but they are all three-wheeled vehicles built for no more than two passengers besides the driver and have a cargo compartment that is either open or an enclosed box. The engines and specifications of delivery tuktuks are usually in the same range as those of passenger tuktuks, being around 200-250cc. Open air truck bed tuktuks are quite common in the commercial centres of cities and are used in Africa for all types of goods including agricultural produce and hardware.

3.4 Four-Wheeler Environment

The reason for the development of such micro-mobility vehicles lies in their lower energy requirements and therefore lower emissions. Significant reductions in greenhouse gas emissions in the transport sector require systemic changes in transport behaviour that are supported by technological progress and resource-saving vehicles. Replacing large and heavy vehicles with micro-mobility options is one possible solution. These very small and light electric vehicles make the aforementioned goals possible.

Electric all wheel drive vehicles have a more favourable ratio of weight-to-payload (passengers or goods) and in addition to the low vehicle weight and small frontal area, the efficiency of the electric drive minimises energy consumption during operation. In contrast to large and heavy passenger cars, the traction batteries in LEVs could be significantly smaller, so that the consumption of critical raw materials is also reduced and thus the production-related greenhouse gas emissions decrease.

Figure 4 shows that greenhouse gas emissions increase proportionally with the size of the battery (around 40 kg to 140 kg CO_2 equivalent per kWh).[12]

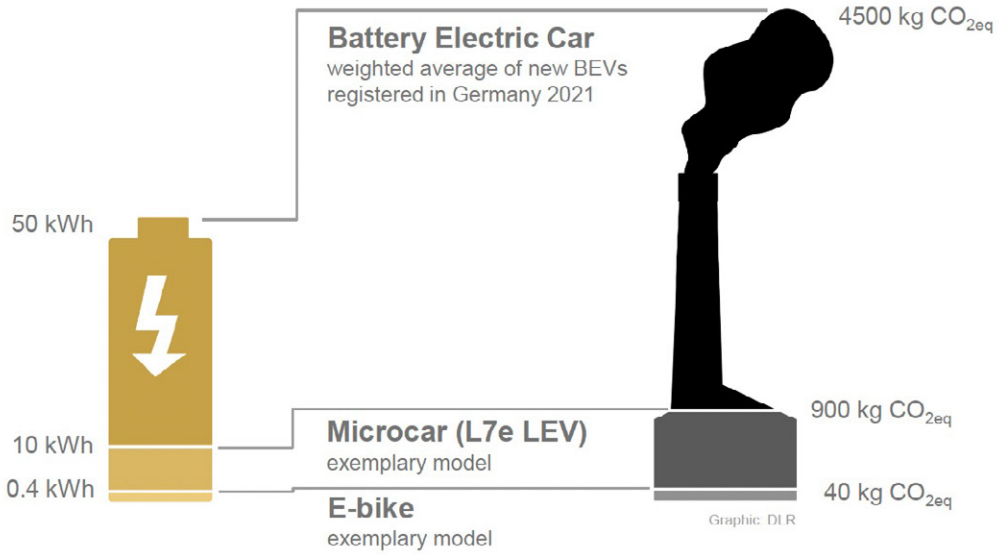


Figure 4: Correlation Between Greenhouse Gases and Battery Size[13]

[12] M. Brost, et al. 2022. The Potential of Light Vehicles for Climate Protection through Substitution for Passenger Car Trips. Final report of the LEV4Climate Study. German Aerospace Centre.

[13] M. Brost, et al. 2022. The Potential of Light Vehicles for Climate Protection through Substitution for Passenger Car Trips. Final report of the LEV4Climate Study. German Aerospace Centre.

Everlectric is a South African company focussing on electric delivery vehicles, charging infrastructure and related financing. Their business concept is now more comprehensive than Battery as a Service and includes the option of a complete electric vehicle-as-a-service. The company offers world leading electric vehicles and chargers, fully managed and supported by experienced high voltage technicians at its EV centres of excellence and via the Everlectric Cloud/application with onsite and offsite support. Everlectric imports a number of these electric delivery vehicles and currently has 40 in operation, with a target to do deliver about 20 units per month. SAIC (Shanghai Automotive Industry Corporation) Motor Corp. is a Chinese automotive design and manufacturing company that currently supports Everlectric.

Everlectric's business model overcomes the current challenges in the adoption of EVs and makes them accessible to the commercial logistics market by providing infrastructure and electric vehicles-as-a-service solution that makes access to EVs easy, convenient and affordable. Everlectric's goal is to make the transition to electric vehicles as easy as possible. Everlectric aims to be a key partner in driving demand for EVs in logistics fleets of customers such as Woolies Dash, DSV and FedEx. The image below shows Everlectric's value proposition in detail.



Figure 5: Everlectric Value Proposition

3.5 Drivers of Demand for Two- and Three-Wheelers in Africa

In many African countries, the economic, social and other forces behind the rise in number of commercial motorcycles are strong: continued population growth, rapid urbanisation, poor roads, lack of infrastructure for pedestrians and cyclists and limited employment opportunities for young men.

Motorcycles are the popular entry-level solution in response to the lack of transport infrastructure in many underdeveloped regions and are both a means of transport and a means of employment. The figure below shows some of the driving forces behind the increasing demand for motorcycles.

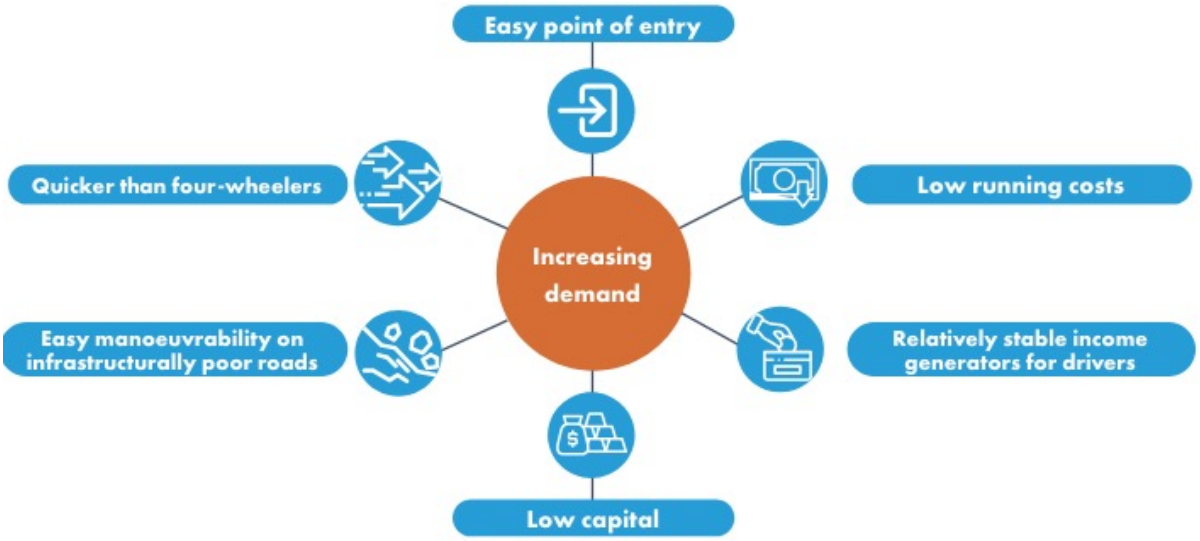


Figure 6: Driving Forces of Demand for Motorcycles in Africa
Source: PRE-E Mobility Report

Despite various challenges, the commercial market for motorcycles continues to thrive and attract the necessary investment in the sector. In some African countries, motorcyclists are benefitting from government support, policy regulation and incentives such as import duty exemptions, increased investment, and market participation across the sector.

3.6 The Case for Electric Motorcycles

Riding an electric two-wheeler has considerable advantages for the user compared to an ICE motorbike. These include faster acceleration, less harmful exhaust fumes and smoke, less vibration and less noise. Electric motorbikes also reduce maintenance costs. The global EV market is expected to reach 80% of sales in all segments by 2050:

- Stronger regulation to support electric vehicles
- Changing consumer behaviour
- EV and charging technology

OEMs around the world are committing to phasing out the production of combustion engines, which means that new vehicles purchased will inevitably be electric vehicles over time. Sub-Saharan Africa remains largely reliant on ICE motorbikes for transport and employment opportunities. This reliance on ICE motorbikes comes with relatively high operating costs and long-term environmental impacts due to the use of fossil fuels. The negative impacts are exacerbated by the limited regulation of emissions and lack of enforcement. The electric motorcycle sector represents a viable solution to the challenges caused by polluting and expensive ICE vehicles.

The lower operating and maintenance costs of electric motorbikes allow riders to earn higher profit margins for the same revenue, resulting in higher income potential and better livelihoods. In addition, electric motorbikes have the potential to promote local economic development and create jobs throughout the production and supply chain, as they consist of fewer components and can be assembled in-country.

The difference in cost of ownership between ICE and e-scooters/bikes is illustrated in a study published in Green Energy and Intelligent Transport 2 (2023), and shown in the graph below.

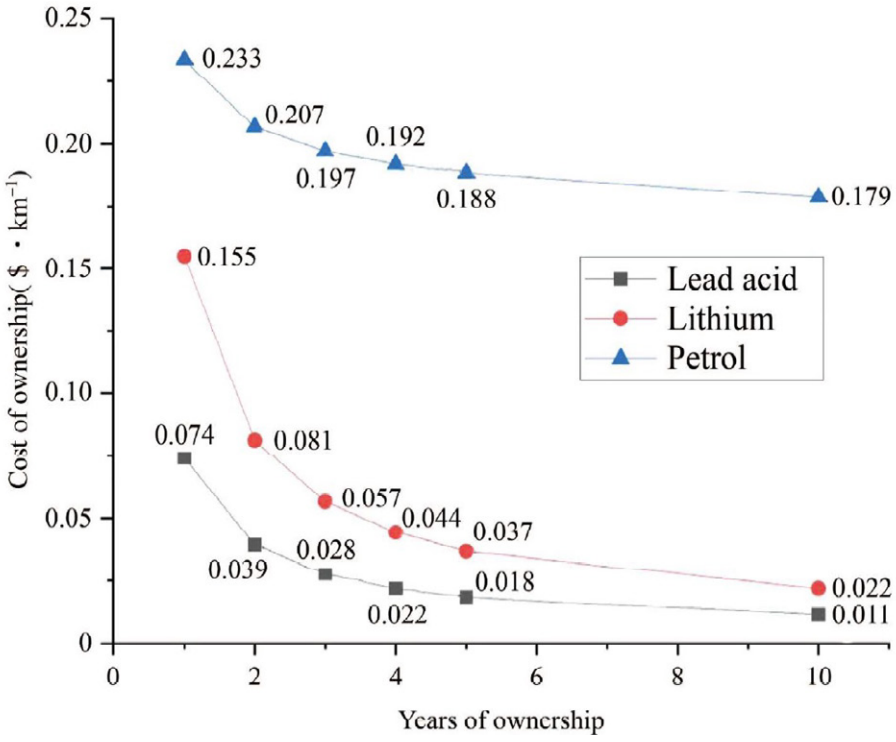


Figure 7: Cost of Ownership Differential Between ICE and Electric Two-Wheelers
Source: Green Energy and Intelligent Transport (2023)

The feasibility of owning an e-bike compared to a combustion engine motorbike shows the cost benefit of running costs over time with fuel prices compared to electricity prices. The advantage and potential cost savings become more apparent in rural areas where electricity can be generated from renewable energy sources (such as photovoltaic and wind power) and where transport and storage costs for fuel become prohibitive.

Local microfinance institutions are working with e-mobility providers to facilitate access to finance for drivers (who are not necessarily creditworthy) by linking loan application processes with data from e-mobility companies such as driver behaviour, earning frequency, monthly income and customer base. This embedded pre-screening facilitates the transition from a rental to an asset leasing model within 6 months and to asset ownership within 12 to 24 months. Good examples of companies in Kenya using the described financing model are: eWaka Mobility Ltd. and Fortune Credit Limited (Microfinancer).

New electric motorbikes are slightly more expensive than ICE motorbikes, with the battery making the electric motorbike more expensive. However, battery costs, which traditionally accounted for around 35% of the BOM value of a two-wheeler, are coming down significantly as manufacturers realise economies of scale and more efficient production and generally move to lower cost LFP batteries. According to recent reports, battery costs have halved within a year and will be around $53/KWh in China by 2024, which is less than 30% of the value of battery electric vehicles.

In Sub-Saharan Africa, two-wheelers are predominantly purchased new, with more than 9 out of 10 two-wheelers purchased for commercial use as taxis or delivery services. Commercial use results in a higher average mileage per vehicle, which improves the total cost of ownership of the electric two-wheeler compared to the ICE two-wheeler. Due to the small battery size of electric two-wheelers, they can be charged via a mini-grid, making them suitable for use in locations with little access to reliable power grid infrastructure. They can also benefit from a battery-swap model, in which a depleted battery is replaced with a fully charged battery from a designated "swap station" in just a few minutes.

These factors suggest that electric two-wheelers will also become more widespread in sub-Saharan Africa, following the example of Asia. Several start-up companies are already investing in the emerging electric two-wheeler market in the region to develop vehicles that are suitable for the local market in terms of cost and durability. For example, Opibus (now ROAM) in Kenya is investing in R&D and local assembly to build an electric motorbike tailored to the needs of Boda Boda riders who require a vehicle with high durability and a range of 130 km per day at a comparable price to an ICE two-wheeler. Companies such as Ampersand in Rwanda are also developing a network of battery exchange stations that allow two-wheeler riders to swap empty batteries for fully charged ones while travelling.

Even with this emerging use case, there are still challenges to overcome. These include the higher purchase price of electric two-wheelers compared to ICE two-wheelers (estimated at $1 700 in mid-2021 compared to $1 000 in Kenya in 2024), inferior batteries and unknown battery life data as motorbikes travel further in sub-Saharan Africa than in Asia, as well as the cost of battery replacement.

Another major problem is the financing of e-bikes and the creditworthiness of riders. The capital market for financing e-bikes is not well established. This means that riders who want to switch to e-bikes may not be able to do so.

Despite these challenges, the TCO for electric two-wheelers is favourable. Despite higher purchase costs, the electric two-wheeler is 25% cheaper than an ICE two-wheeler over a five-year life cycle.

4. THE CHARGING INFRASTRUCTURE PILLAR

This section of the report discusses charging infrastructure as a key supporting pillar in the NEV eco-system which forms the backbone of electric mobility.

4.1 Charging Infrastructure Business Models

Business models for electric vehicle charging infrastructure are emerging across Africa, focussing mainly on the "battery as a service" (BaaS) model, where companies rent out the battery to reduce the purchase cost of an electric vehicle. As with all EV segments, the cost of an electric two-wheeler today is much higher than a petrol two-wheeler. An analysis of UKAid's Manufacturing Africa programme in Kenya in 2021 shows that the average price of a locally assembled ICE two-wheeler is $1 300, while the average price of a locally assembled electric two-wheeler is currently $1 800. Falling battery costs could bring this price down slightly over the next five years. Incentives, product innovations or innovations in the business model would be required to bring the costs down to the same level as ICE two-wheelers within this time frame.

Ampersand in Rwanda relies on a BaaS model, where the electric two-wheelers are sold without the battery, but the battery is offered on a rental basis, including access to a network of battery exchange stations. Similarly, Ugandan company Zembo sells electric two-wheelers to taxi operators on a pay-as-you-go basis and offers batteries as a service through its battery swapping network. The company's strategy is to expand its network through risk-sharing mechanisms such as franchise models and to reduce labour costs through the use of automated swap cabinets.

As with electric two-wheelers themselves, further experimentation is needed to determine the best charging infrastructure product for sub–Saharan Africa, particularly to minimise the capital burden of financing an extensive network of swap stations with a large battery stock or public charging points. Indeed, a large swap network with low battery utilisation can be loss-making, especially as the cost of swaps must remain in the $1 to $2 range to continue to maintain the electric two-wheeler competitiveness against the ICE two-wheeler. It is therefore vital to strike a balance between the battery swap network demand and the scale of investment needed.



Figure 8: Overview of Business Model Adopted by E2W Players
Source: Shell Foundation, Financing the Transition of Electric Vehicles in Africa

African players can capitalise on the experience of Asian players when experimenting with charging infrastructure to reduce the cost of charging infrastructure. This includes limiting the number of swaps per customer per month, focusing on self-service swap stations to minimise labour costs, standardising battery technology across OEMs to achieve economies of scale, and conducting geographic mapping (e.g. in collaboration with ride-hailing companies) to locate swap and charge stations at the highest throughput points to increase overall utilisation.

Table 1: Approaches in Asia to Improve Cost Effectiveness of Battery Swap Infrastructure

Initiative	Impact	Example
Battery interoperability with common batteries across E2W models to enable sharing of battery swapping infrastructure	Promotes **scale** and therefore **optimises capex** and labor spend, and increase revenues	gogoro Gogoro sells its battery technology to partner OEMs, and then charges drivers subscription fees for use of battery and charging infrastructure
Discount on electricity tariff for charging station owner	**Decreases energy cost**, therefore improves profitability of charging stations (which might otherwise be uneconomical)	Bluebird PLN Bluebird, a transportation company in Jakarta with an EV fleet, received a 50% power price discount from PLN
Self-service battery swap stations	**Decreases labor cost**, therefore improves profitability of swap stations (which might otherwise be uneconomical)	Grab Grab/Gojek, a delivery service in Indonesia, has developed a self-service battery swapping cabinet that provides standardized batteries
Optimizing battery swap station locations	**Increases swap station utilization**, therefore reducing battery stock requirement	gojek The company expects the cabinets to have high enough utilization to be profitable and therefore is attracting local partners such as convenience stores to install and operate them without requiring extra labor cost
Battery-as-a-Service with a monthly subscription fee, limiting **number of swaps or using tiered fees for usage levels**	**Decreases battery stock required** (encourages home charging) Improves **profitability per battery**	gogoro Charges a tiered fee model depending on level of usage

Source: Shell Foundation, Financing the Transition of Electric Vehicles in Africa

Unlike ICE vehicles, EVs can be charged at widely distributed charging stations. This can be at home, at work, in a shopping centre, at entertainment venues or at a petrol station. In most cases, this is not done while driving, but before or after, while the vehicle is parked. Around 80% of private vehicle charging takes place overnight at home.

		Battery Capacity	Motor Power	Range	Max Speed
	GenZe eBike	0.3kwh	250 W (0.5hp)	30 miles (48 km)	20mph (32 kph)
	Genze 2.0 Scooter	1.6wh	1kW (2hp)	30 miles (48 km)	30 mph (48kph)
	Gogoro Scooter	2.6wh	7kW (9.5hp)	62 miles (100 km)	60 mph (95kph)
	Nissan Twizy	6.1wh	13kW (17hp)	50 miles (80 km)	50 mph (80kph)

Figure 9: Energy Storage Needs for L-Class Vehicles

Decisions regarding infrastructure for EVs depends on the purpose of the vehicle, operational requirements, route characteristics and energy supply options.

4.1.1 Scaling Up Charging Infrastructure[14]

Gogoro's operations provide guidance on how to ramp up infrastructure production to high volume.

Since its launch in Taiwan, Gogoro has achieved considerable success, growing from an initial 70 Go stations to almost 1 500 stations by the end of 2019, for which Gogoro's more than 225 000 customers pay monthly fees. Gogoro strategically places these stations approximately every 500 metres in locations such as shopping centres, grocery shops, car parks and cafés. The company has introduced consumer battery swapping on a large scale, proving that its business model is not only viable but also practical.

Gogoro allows third parties to use its infrastructure. For example, COUP - an eScooter sharing service in Europe - operates the Gogoro Smart Scooter and the Gogoro infrastructure in Berlin, Paris and Madrid. Using the same standard battery and swapping stations, it should enable battery volume attractive to producers.

[14] https://www.frost.com/wp-content/uploads/2020/08/Gogoro-Award-Write-Up.pdf

5. THE BATTERY PILLAR

South Africa offers potential investment opportunities in the battery sector, driven by the increasing demand for energy storage solutions in the renewable energy sector and the growing demand for electric vehicles. Fuel savings and government incentives for greener transport are also fuelling demand. New hybrid and electric car models from original equipment manufacturers are accelerating market growth. In addition, industrial batteries are increasingly being used in applications such as emergency power supply for telecommunication base stations and data centres or power supply for industrial plants, which contributes significantly to the growth of the industrial battery market.

This section of the report sets out the background and market environment for batteries.

5.1 The Battery Environment

In 2023, South Africa imported $1.75bn (33.02bn ZAR) in LIB (Lithium-Ion Batteries) across all needs**,** more than double the 2022 figures ($0.73bn) (13.77bn ZAR). The "South African Battery Overview, 2027"[15] states that the battery market is expected to grow exponentially in the short to medium term (2030). The South African battery market is projected to grow at CAGR of more 8% during the 2022 – 2030 forecast period. Driven by rising demand for EVs, the LIB global market demand is expected to reach 2.8 TWh by 2030. The rising demand for LIB is underpinned by the following:

1. LIB are rechargeable batteries traditionally used in electronic devices and new energy vehicles. They have broad applications and have 4x more capacity than lead acid batteries.
2. They are maintenance free and are lightweight, making them preferable for car usage.
3. The price of the LIB has reduced by approximately 80% in the past decade, making it more cost-effective in comparison to other battery technologies.

In a report from the World Bank Group[16] compiled by consultancy Customized Energy Solutions (CES), it is reported that South Africa could play a big role in the global battery value chain with the potential for 10-15GWh of domestic demand for battery energy storage by 2030.

The country's battery storage market could reach 9 700MWh of demand by 2030 and 10 400MWh including the wider Southern Africa region, in a base case scenario[17]. In the best-case scenario, that demand could reach 15 000MWh for South Africa and 17 000MWh for the wider region. This is a big increase from just a few hundred MWh in 2020.

Thanks to a higher cycle life and better charge and discharge performance, LIBs became the first choice for solar and wind energy storage. Today there are several Lithium battery assemblers in South Africa. These include Freedom Won, Solar MD, Blue Nova, Balance Cell and REVOV.

The combination of unprecedented levels of loadshedding and a tax incentive for the installation of rooftop solar systems has contributed to a dramatic increase in the installation of commercial, industrial, and residential rooftop solar. This is reflected in the large increase in imports of panels, batteries, and inverters for solar PV installations in 2022 and the first half of 2023. Estimated South African rooftop solar PV capacity increased from 983MW in March 2022 to 5,1GW in January 2024, an increase of 519%.[18]

To meet the set goal of net zero emissions by 2050 as set out in the Just Transition Framework by the Presidential Climate Commission[19], South Africa will need to deploy an estimated 89GW of solar PV, which represents a net increase of more than 83GW over current installations. This enormous growth will most probably be accompanied by the adoption of energy storage systems, the majority of which are likely to be lithium batteries. However, as these batteries near the end of their operating life, which is around 5 years or at least 2,000 charges,

[15] Data Bridge Market Research. https://www.databridgemarketresearch.com/reports/south-africa-battery-market
[16] World bank Group. https://documents1.worldbank.org/curated/en/099155502102332395/pdf/
[17] World bank Group. https://documents1.worldbank.org/curated/en/099155502102332395/pdf/
[18] Energy Monitor. 2023. South Africa's unprecedented rooftop solar boom. South Africa's unprecedented rooftop solar boom (energymonitor.ai)
[19] https://www.climatecommission.org.za/just-transition-framework

careful disposal is required. Furthermore, with the arrival of electric vehicles in the South African market, the accumulation of batteries complicates the situation, needing a comprehensive solution.

South Africa imported lithium-ion cells and batteries to the value of $1.1 billion, during the first 6 months of 2023[20]. If we use current pricing estimates for volume orders of $250/kWh for stationary storage, it will mean South Africa imported about 4.4 GWh of lithium-ion cells and batteries in the first 6 months of the year.

This is a big jump from the $0.7 billion worth of cells and batteries imported in the whole of 2022 and four times on the $0.2 billion imported in 2021. SA imports of lithium-ion batteries reached $1.75bn in 2023, more than double the 2022 numbers ($0.73bn). At an average of $139/kWh, that's about 12.5GWh (or about 3.8-5.0GW of capacity). South Africa's lithium-ion battery and cell imports ate depicted in the graph below.

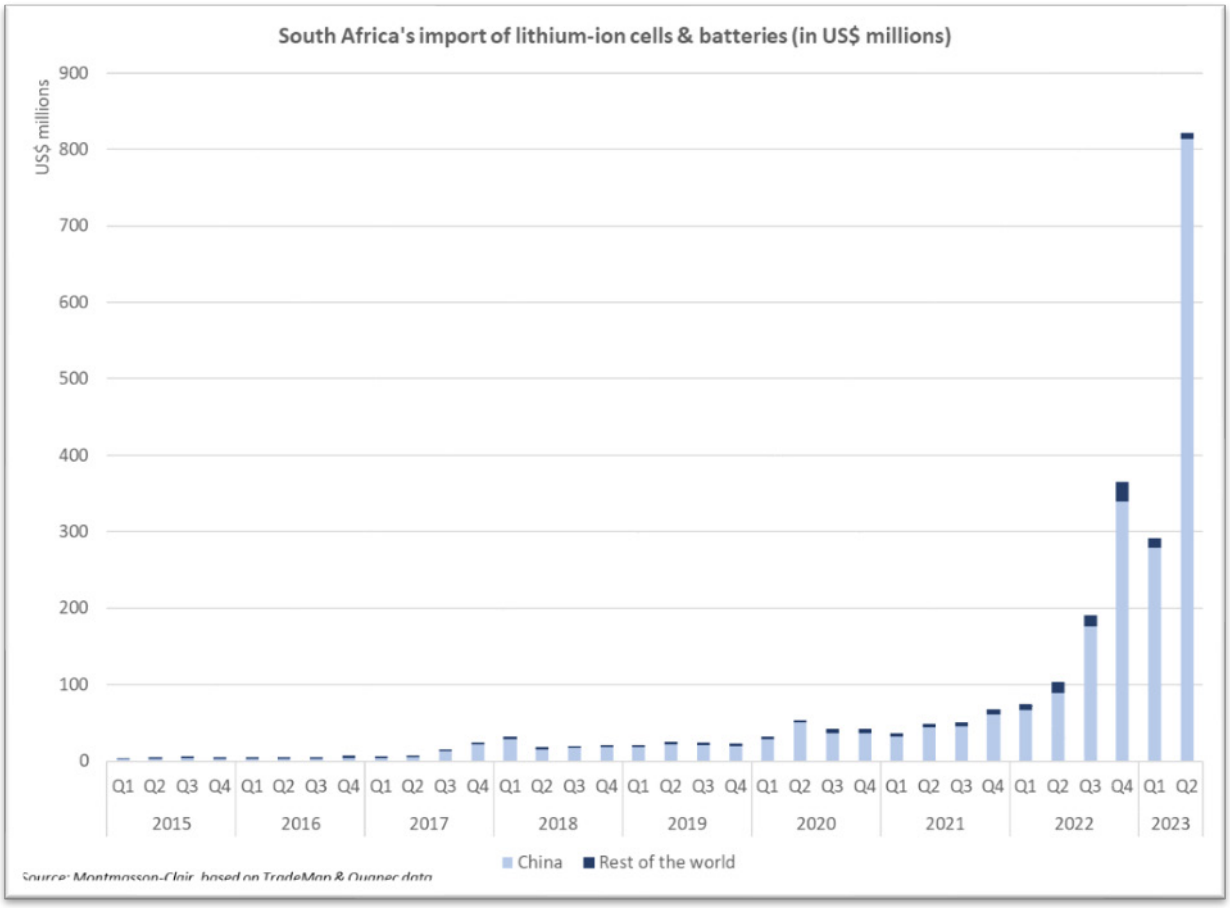


Figure 10: South Africa's Import of Lithium-Ion Cells & Batteries (in US$ millions)

The Southern Africa region has a lot of potential on the upstream side of the battery value chain[21]. The region has many of the battery minerals required for the manufacture of lithium-ion batteries, which is currently the dominant chemistry for battery energy storage. South Africa, for example, holds about 78% of the world's manganese[22]. South Africa, however, has a small share of beneficiated manganese, e.g., ferromanganese[23]. Most mineral beneficiation is currently happening in Asia, who provides up to 97% of the current global LIB demand[24].

The logistical advantages of closer geographical proximity, coupled with improved regional free trade policies, such as the African Continental Free Trade Area (AfCFTA), the African Union (AU) Agenda 63, and the SADC Industrialisation Strategy and Roadmap (SISR), which provide a framework to fast-track the participation of member states in global value chains, could offer a range of advantages in accessing and utilising these raw materials.

[20] https://www.tips.org.za/news/item/4594-south-africa-imported-1-1-billion-4-4-gwh-of-lithium-ion-cells-batteries-in-first-6-months-of-2023
[21] World Bank. 2023. https://www.energy-storage.news/world-bank-south-africa-could-play-significant-role-in-global-battery-value-chain-by-2030/
[22] Greencape. 2021. https://greencape.co.za/assets/The-Electric-Vehicle-Ecosystem-and-Associated-Value-Chains.pdf
[23] Greencape. 2021. https://greencape.co.za/assets/The-Electric-Vehicle-Ecosystem-and-Associated-Value-Chains.pdf
[24] Greencape. 2021. https://greencape.co.za/assets/The-Electric-Vehicle-Ecosystem-and-Associated-Value-Chains.pdf

The country has early-stage activities in the lithium-ion battery value chain. 99% of the 2020 demand for battery storage in South Africa came from the behind-the-meter energy storage solutions (ESS) market, including commercial, industrial and residential applications[25]. Local companies active in the space today include Maxwell and Spark, Blue Nova, Balancell, SolarMD and Freedom Won.

According to recent reports by Bloomberg, prices for batteries in China are plummeting, and the implications are just starting to ripple outward for the global automotive market. Over the last year, the price for lithium iron phosphate, or LFP, battery cells in China have dropped 51% to an average of $53 per kilowatt-hour[26]. The average global price of these batteries in 2023 was $95/kWh.

There are several factors driving prices lower. The first is raw-material prices, which have fallen sharply over the last 18 months. The cathode is where most of the raw-material costs in a battery come from, and the cathode share of total cost for an LFP cell in China has fallen from 50% at the beginning of 2023 to less than 30% this year. The second driver is overcapacity that's leading manufacturers to cut prices to maintain market share. Finally, BNEF's bottom-up battery cost model shows how close average prices are now to estimated manufacturing costs, indicating that margins for vendors are shrinking[27].

South Africa's diversified automotive industry is currently in the early stages of transitioning to EVs to maintain its leading position in the regional market. EVs are therefore expected to drive the growth in the country's battery ecosystem. A report by the World Bank states that South Africa could localise some 5GWh of lithium-ion battery cell production by 2030[28].

[25] World Bank. 2023. https://www.energy-storage.news/world-bank-south-africa-could-play-significant-role-in-global-battery-value-chain-by-2030/
[26] https://www.bloomberg.com/news/newsletters/2024-07-09/china-s-batteries-are-now-cheap-enough-to-power-huge-shifts
[27] https://www.bloomberg.com/news/newsletters/2024-07-09/china-s-batteries-are-now-cheap-enough-to-power-huge-shifts
[28] World Bank. 2023. https://ces-ltd.com/world-bank-south-africa-could-play-significant-role-in-global-battery-value-chain-by-2030/#:~:text=CES%20reckons%20that%20South%20Africa,battery%20(VRFB)%20value%20chain.

6. THE BATTERY RECYCLING PILLAR

Battery recycling is a vital pillar supporting a circular economy and a sustainable NEV ecosystem. This pillar helps to close the loop by returning valuable materials back into the supply chain, thereby reducing waste and conserving natural resources. This section of the report sets out the need for battery recycling.

6.1 The Battery Recycling Environment

Currently, used lithium-ion batteries (LIB) collected in South Africa cannot be recycled locally as there are no recycling facilities for lithium-ion batteries. As a result, the batteries are either stockpiled or shipped to available facilities in other parts of the world. As the Department of Environment, Forestry and Fisheries (DEFF) has banned lithium-ion batteries from landfill, the only legal option is to export the lithium-ion batteries for recycling. Due to the significant risk of fire, batteries shipped abroad for recycling require the prior informed consent procedure under the Basel Convention.

Shipping agencies are therefore often unwilling to ship these batteries, and if they do, significant fire precautions are required. These fire precautions limit a 20-tonne container to 5 tonnes of LIB embedded in 15 tonnes of sand. This export-for-recycling model has been tested in Africa, but the transport costs far exceed the revenue generated (Agese, 2022). For this reason, the export-for-recycling model is unprofitable, but it is also currently the only legal option for handling used LIBs. E-waste recyclers in South Africa now charge a "Producer Responsibility Organisation" (PRO) fee of R7/kg of lithium-ion batteries.

From August 2021, the disposal of hazardous e-waste, including lithium-ion batteries, in landfill sites will be banned under a law proposed by the DEFF. The Extended Producer Responsibility (EPR) regulations stipulate that an effective waste management system for lithium-ion batteries will be introduced in 2021-2022, including the establishment of a pilot recycling plant. South Africa has existing industrial structures for the recycling and recovery of lead from lead-acid batteries. The recycling of lithium-ion batteries could be carried out by existing industry players and regulated similarly to lead-acid batteries. The recovery process includes methods designed to recover valuable metals and solve the environmental problems associated with battery disposal. This initiative is in line with broader goals that focus on achieving a closed-loop recycling systemloop system, where metals retrieved from used batteries are repurposed to produce new energy storage systems.

Current commercial recycling methods include pyrometallurgical (smelting), hydrometallurgical technologies and direct recycling. Pyrometallurgical methods, which are applicable to any battery chemistry and configuration, are capital intensive and result in significant greenhouse gas emissions. Although this approach achieves a high recovery of important metals such as Co, Ni, Cu, Li and Al are lost in the slag. Hydrometallurgical methods, which are recognised as less energy intensive with high yield and material purity, can be costly due to reagent costs. These methods can be used individually or in combination. The direct recycling method, which has been demonstrated at laboratory scale, enables the efficient recovery and reintroduction of battery materials into the supply chain with minimal additional processing. South Africa has the capability and expertise for these recovery processes.

Driven by the increasing demand for electric vehicles, the global LIB market in China is expected to reach 6 TWh by 2026. As a result, demand for critical materials is expected to increase, with demand for lithium expected to increase by 5.3 times and cobalt by 5.2 times the 2020 level by 2030.

Stockpiles of used batteries in South Africa and Africa will continue to rise. A company called uYilo, which operates a test facility for second-life batteries in South Africa, proves that it is possible to set up facilities for the reuse and recycling of batteries. Recycling used batteries can help address this material shortage by reducing dependence on lithium mining by 25% and cobalt by 35%. It would also ensure the local availability of recycled key materials.

6.1.1 Battery Recycling Opportunities and Challenges

The battery recycling process, as illustrated in the figure below, includes five major steps.



Figure 11: Battery Recycling Process

To develop a robust LIB recycling ecosystem, it is important to identify the possible pathways that ensure business profitability. A study by Lander et.al. investigates the economic feasibility of battery recycling with a focus on different markets including Belgium, China, the United Kingdom, the United States, and South Korea[29]. The authors find that costs or profits of the recycling of batteries and selling the recycled materials range from -$21.43 (404 ZAR) to +$21.91 (413 ZAR) per kWh of recycled batteries, depending on the recycling pathway, the dominant battery chemistries and commodity prices.

The value of metals recovered from batteries and the cost-effectiveness of the recycling technologies greatly affect the profitability of battery recycling. The study finds that net profitability of recycling is best achieved when the battery is recycled domestically, contains comparatively high amounts of nickel and cobalt, as in NMC- and NCA-based batteries, and has low disassembly costs[30].

Furthermore, an economies of scale analysis for recycling profitability in the UK, suggests that the breakeven point for the recycling profitability of NCA batteries can be achieved with an annual recycling capacity of 17 000 tons for pyrometallurgy, 7 000 tons for hydrometallurgy, and 3 000 tons for direct recycling technology[31]. The profitable economies of scale for NCA battery recycling without revenue from cobalt increases to an annual capacity of over 50 000 tons for pyrometallurgy, and ±17 000 tons for hydrometallurgy.

The following table summarises the current opportunities and challenges of the three LIB recycling processes: pyrometallurgical, hydrometallurgical and direct battery recycling.

[29] Lander et al., 2021 https://doi.org/10.1016/j.isci.2021.102787
[30] Lander et al., 2021 https://doi.org/10.1016/j.isci.2021.102787
[31] Lander et al., 2021 https://doi.org/10.1016/j.isci.2021.102787

Table 2: Opportunities and Challenges for Battery Recycling

Recycling pathway	Opportunities	Challenges
Pyrometallurgical recycling	• Cobalt, copper, and nickel can be recovered • Mature technology; applied in industrial recycling plants • Flexible; suited for mixed feedstock of battery chemistries	• Aluminum and lithium are usually not recovered; graphite, electrolyte, and plastics cannot be recovered • Pyrometallurgical step: Comparatively high greenhouse gas emissions; production of toxic gases and air pollutants; hazardous solid waste • Hydrometallurgical step: Potential water contamination due to the use of acids; requires water treatment • High capital costs • Large-scale, centralized recycling plants, require long distance transport of batteries
Hydrometallurgical recycling	• Aluminum, cobalt, copper, lithium, manganese, and nickel can be recovered • High purity of recovered metals • Mature technology; applied in industrial recycling plants	• Graphite, electrolyte, and plastics are usually not recovered • Shredding processes: Potential particulate matter emissions and safety requirements • Hydrometallurgical step: Potential water contamination due to the use of acids; requires water treatment • High operating costs • Recycling plants optimized for specific battery chemistries
Direct recycling	• Cathode and anode powder, aluminum, copper, electrolyte, and plastics can be recovered • Cathode structure is retained, can be reused in new battery cell • Applicable to most if not all battery chemistries, including LFP	• Industrial maturity not proven; applied on laboratory and pilot scales • Safety requirements during manual dismantling process • Recycling plants specialize in specific battery chemistries

Sources: Bej et al. (2022); Doose et al. (2021); Beaudet et al. (2020); Gaines (2019); Harper (2019); Neumann et al. (2022)

6.2 Battery Reuse

Reusing batteries is crucial to ensuring a circular economy as it minimises waste and reduces the need for new batteries, thus promoting environmental sustainability. The process of battery reuse is illustrated in the figure below.



Figure 12: Battery Reuse Process

The new Li-ion battery systems used in electric vehicles have an average capacity of 50 kWh and are expected to be discarded when they reach approximately 80% of their initial capacity, because they are considered to no longer be sufficient for traction purposes[32]. The graph below shows that batteries running between 80%-30% capacity can still be used in less demanding applications, such as energy storage systems (ESS) or smaller mobile applications[33].

[32] https://pdfs.semanticscholar.org/697d/af43b32d25f347f411bb15dc1e234386c5d9.pdf
[33] https://www.capgemini.com/insights/research-library/powering-change/

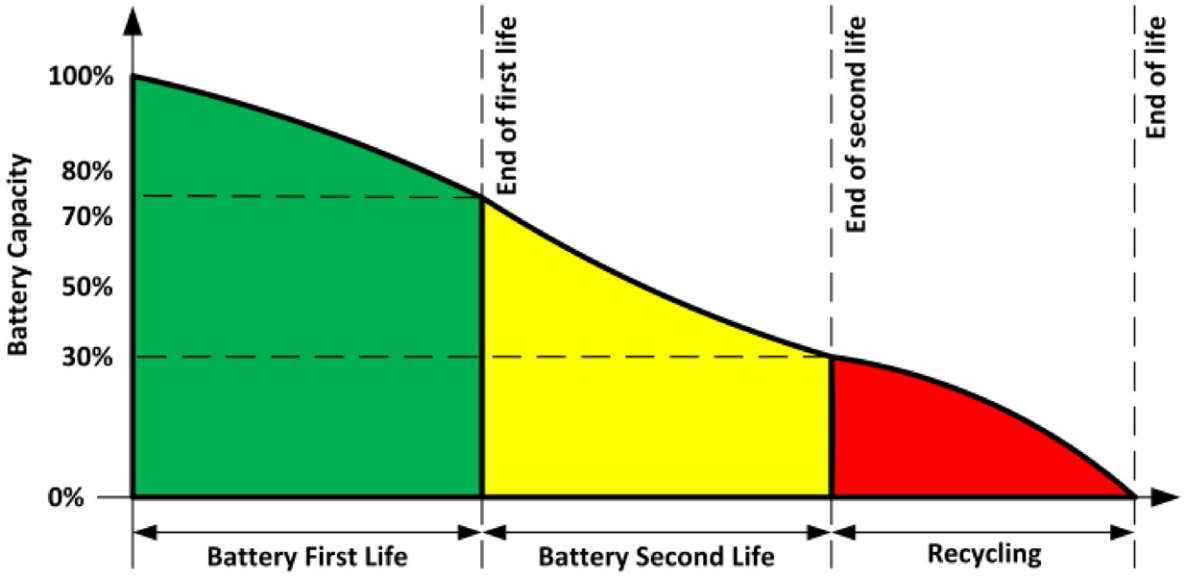


Figure 13: Capacity Throughout a Battery's Lifecycle

There are multiple emerging options for reusing batteries at EOL. But overall, current solutions focus on the subsequent use of these batteries as energy stores (i.e., Energy Storage Systems (ESS) in different applications). Of all the use cases currently being explored, most of the players in this industry opt for three that are dedicated to reusable batteries[34]. The three use cases are:

Mobile applications

- Batteries or their parts can be reused in the mobility space, where less storage is required (e.g., small BEV, PHEVs, and micro mobility applications, such as scooters and bikes)
- EV Charging stations (buffer storage)

Utility-scale storage

- Frequency and voltage regulation (peak loads)
- Energy arbitrage (leveraging price differences in markets to reduce the cost of electricity)
- General capacity increase of storage systems (meeting the demand for additional storage systems, such as the relevance in storage of electricity generated through solar and wind)

Residential and commercial storage

- Both home and enterprise energy storage are increasingly popular

[34] https://www.capgemini.com/insights/research-library/powering-change/

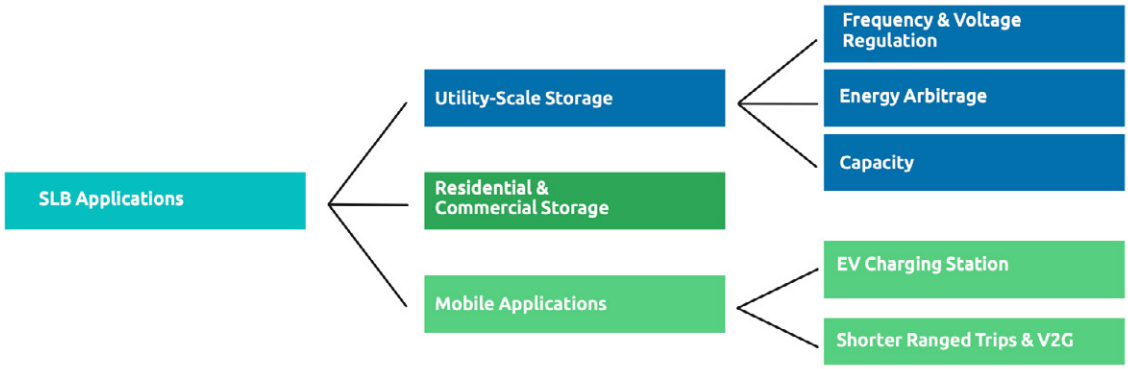


Figure 14: Second Life Battery Applications

A general requirement for the use of batteries in second-life and recycling scenarios is to check the state of health (SOH) of the battery. This is an important step in determining the remaining capacity and functional cells. The SOH check is used to assess the usability of a battery for second-life and recycling applications. This is currently both costly and labour-intensive.

The potential to utilise solutions for the mass market here cannot be overestimated. Technological development in the field of SOH, which is now being defined more quickly, is therefore flourishing. One option, for example, is that wireless connections embedded in the batteries could enable automatic remote reading of a battery's vital signs. The health check is a necessary step to obtain certification and battery status information for secondary use of the batteries.

Various studies support the conclusion that the economic feasibility of battery reuse depends on several parameters, including the selling price of the used battery. The study found that the purchase price of the used battery from its original owner accounts for the largest share of its selling price as a second battery.

Clearly, the market for waste batteries is one of the most interesting sustainable solutions of recent years. Advances in technology and an influx of new players have created a thriving industry. However, there are still no fully established solutions. The majority of existing initiatives are still focused on research projects or early-stage trials. Opportunities in this area are being explored in all major regions of EV development: North America, Europe and Asia.

The following table summarises the challenges that arise during the battery reuse process.

Table 3: Battery Reuse Challenges

Battery reuse process	Challenges encountered
Battery collection	• Lack of traceability mechanisms to ensure the battery is collected and does not end up in landfills • Battery removability is a growing concern as manufacturers push toward more vehicle-integrated battery design • Lack of regulations that clearly define who is responsible for the battery when it reaches end of life • Lack of information at the very early stage of collection regarding the state of the battery (ownership, SOH, metal content, damages, etc.) to redirect the end-of-life battery in the right destination (repair, reuse, or recycle) and avoid non-needed logistics
Battery transport	• Cumbersome licensing processes • Costly safety measures • Long distances needed to be traveled to reach the reuse center
Battery inspection	• Lack of readily available information on battery design, chemistry, state of health, and usage history may require costly tests and limit ability to optimize reuse processes.
Battery disassembly	• Modules and cells are not designed to be disassembled • Large variety in terms of battery design, so process is labor intensive
Sorting and regrouping	• Identifying the right set of indicators and thresholds to maximize performance of a battery in its second-life application • Developing a sorting algorithm for batteries with similar electrochemical properties
Battery second-life placement	• Adapting control strategies to stabilize power output or to limit events such as overheating or discharging • Developing effective equalization strategies to reduce inconsistencies between the electrochemical behavior of individual cells or modules • Developing fault-diagnosis algorithms adjusted to second-life batteries to quickly detect events such internal short circuits

6.3 The Key Policy Levers for Battery Reuse and Recycling

The table below lists the key policy levers to scale up battery reuse and recycling practices and provides worldwide examples of policy development for each. The list of examples is not exhaustive but is intended to provide examples of how such policies have been implemented in the early market.

Table 4: Policy Levers for Battery Reuse and Recycling

Area of intervention	Policy lever	Examples of existing policy developments
Battery traceability and collection	• Battery removability • Battery traceability mechanisms • Regulations that clearly define who is responsible for the battery when it reaches end of life	• **China:** The government released a set of policies that place the responsibility of collecting electric vehicle end-of-life batteries on manufacturers or importers (Ambrose and O'Dea, 2021). In 2018, a platform was created to trace batteries throughout their lifetime (Reuters, 2018).
Building domestic capacity for reuse and recycling	• Incentives and grants to support the development of domestic capacity for reuse and recycling	• **United States:** The Battery Materials Processing Grants makes more than $3 billion available to state and local governments, for-profit and non-profit entities, and national laboratories to support domestic capacity for the reuse and recycling of batteries through project demonstration and other uses (U.S. Department of Energy, 2022).
Battery information	• Regulations for the disclosure of battery information are needed to optimize the battery reuse and recycling process	• **European Union**: The European Commission proposed a labeling requirement for manufacturers to disclose information on batteries, such as the date of manufacture, chemistry, and hazardous substances. The Commission has developed language for the creation of a battery passport, which links to a digital platform where manufacturers would disclose battery data to facilitate third-party reuse or recycling (European Commission, 2020).
Battery standards	• Standards on battery durability • Standard on accuracy and reporting of the state-of-health metric • Standards on safety when handling end-of-life batteries	• **California:** The Advanced Clean Cars II regulations set battery durability standards require that batteries in electric vehicles of model year 2026 and later maintain at least 80% of their range for 10 years or 150,000 miles (California Air resources Board, 2022a). Furthermore, California proposes an accuracy standard for reporting batteries' state of health (California Air Resources Board, 2022b). • **United States and Canada:** the UL 1974 Standard for Evaluation for Repurposing Batteries sets general safety standards for sorting and grading used electric vehicle batteries and estimating their SOH (UL Standards, 2018).
Recycling mandates	• Element-specific mandates on proportion of material that need to be recovered • Element-specific mandates on recycled material to be used in new manufactured batteries	• **European Union**: the upcoming Battery Regulation will mandate element-specific recovery rates for battery recycling and element-specific shares of recycled material to be used in the production of new batteries (European Commission, 2022b).
Research and development	• Investments in research and development to optimize reuse and recycling processes	• **United Kingdom:** Through its Critical Mineral Strategy, the United Kingdom aims to become a scientific knowledge leader on battery material recovery and recycling. Different funding initiatives are being put in place to support a circular economy (United Kingdom Department for Business, Energy & Industrial Strategy, 2022).

7. STRATEGY TO ESTABLISH A NEV ENVIRONMENT

In recent years, the South African NEV sector has experienced significant growth, fuelled by various aspects such as increased environmental awareness, interest from government stakeholders and technological advancements. The uptake of NEVs in South Africa has been slower compared to other countries due to the high initial cost of electric vehicles, lack of charging infrastructure and range anxiety among customers.

The government has taken initial steps to encourage the adoption of NEVs in the domestic market by introducing incentives. The incentives introduced include tax breaks, support programmes to fund research initiatives and the implementation of measures to reduce emissions from internal combustion engines (ICE).

This report assumes that the introduction of NEVs in the South African market is still in the early stages of development. There is significant potential for growth in the sector as technology advances, electric vehicle infrastructure expands and consumers become accustomed to the concept. Significant investment is required to create a favourable environment to support the successful adoption of a sustainable NEV ecosystem.

How do we prepare South Africa?

Government intervention is needed in the form of policies, incentives, and financing.

International and local partnerships to transfer knowledge and develop skills in South Africa.

7.1 Policies

This section of the report sets out general principles for policy and strategy for the promotion of NEVs in Africa in general and in South Africa, more specifically. It then briefly sets out a policy programme for NEVs followed by specific proposals for policy regarding L-class vehicles.

Motorcycle policy options in the light of current automotive policy are set out in Annexure A: Policy Options. Consideration could be given to the partial incorporation of motorcycles into the APDP. It is noted that full incorporation would be a major policy adjustment. Steps that could be taken to partially incorporate the sector are set out in Annexure A: Policy Options.

7.1.1 Policy Principles for The Green Transition and NEVs

The rate of the green transition to NEVs is slower in Africa than in other regions. This has some advantages as it allows more time for adjustments, but it could also result in the closing of 'green windows of opportunity'.

Africa accounts for only 3.9% of global emissions and an even lower percentage of historical emissions[35]. These shares can be expected to rise as development proceeds. In adopting a green NEV agenda, African countries must prioritise their own developmental needs. Nevertheless, as Altenburg and Rodrik (2017) point out, there are many reasons why governments based on their national, rather than international, goals may want to accelerate the transition to the green economy[36]. These objectives include the need to avoid being locked into unsustainable and obsolete technologies and infrastructure. There are also innovation possibilities which could create new industries and associated job creation. Another important objective is to reduce air pollution resulting in major associated health benefits[37].

[35] Statista. Africa's share in global CO_2 emissions. 2021. https://www.statista.com/statistics/1287508/africa-share-in-global-co2-emissions/
[36] Harvard University. Green Industrial Policy. 2017. https://drodrik.scholar.harvard.edu/files/dani-rodrik/files/altenburg_rodrik_green_industrial_policy_webversion.pdf
[37] Harvard University. Green Industrial Policy. 2017. https://drodrik.scholar.harvard.edu/files/dani-rodrik/files/altenburg_rodrik_green_industrial_policy_webversion.pdf

In general, policy and strategy need to take account of the following:

- Policy outcomes need to be inclusive. For example, if subsidies are to be used to boost consumption of new energy vehicles it would be best to support low-cost vehicles such as two-wheelers or vehicles used for public transport.
- Financial constraints are especially binding in Africa. This limits the possibilities for subsidies for consumers. An example is the difficulty of subsidising the purchases of electric vehicles as has been encountered in developing support measures for light EVs in South Africa. The shift to NEVs will also reduce revenue from fuel taxes and supplementary forms of finance will be required. In the 2023/24 financial year, fuel taxes realised R93.4 billion (5% of government revenue). Within the transport sector revenue could be raised by smart taxes on road use, including congestion charges. Funds would also need to be generated from other sources, including sources outside of the transport sector.
- Policies need to be targeted and aimed at achieving co-benefits such as the reduction of pollution. The health costs of air pollution are extremely high and rising rapidly in Africa.
- Policies also need to support domestic development, especially industrialisation. This objective will be greatly facilitated by regional integration and the development of regional value chains as has happened within SADC and will develop further under the AfCFTA. The levers of the AfCFTA include tariff phase downs, appropriate and harmonised rules of origin, the removal of non-tariff barriers (NTB's) and enhanced trade facilitation (UNDP). In the automotive sector, the rules of origin still need to be finalised to enable free automotive trade across the continent. The deepening of regional integration creates the potential for scale and specialisation thereby greatly enhancing the possibilities for industrialisation including NEVs. According to the United Nations Conference on Trade and Development (UNCTAD, 2021)[38], the automotive industry is the sector which will benefit most from regional integration in Africa.
- Existing subsidies which slow the green transition (e.g. fossil fuel subsidies) should be phased down or removed. Global subsidies on fossil fuels are colossal and are also very high in South Africa[39]. As indicated in Table 5 petrol prices in some African countries (Egypt and Nigeria) are exceptionally low. Reducing these subsidies would have fiscal benefits and create more optimal conditions for the transition to NEVs. Of course, the phasing down of subsidies on petrol is politically complicated and needs to happen gradually.

[38] https://unctad.org/system/files/official-document/aldcafrica2021_en.pdf
[39] IISD. South African Fossil Fuel. 2024. https://www.iisd.org/articles/press-release/south-africa-fossil-fuel-subsidies-energy-crisis

Table 5: Petrol Prices in Selected Countries (2024)40

Countries	Petrol price ($/litre)
China	1.22
Egypt	0.28
Germany	1.98
Ghana	1.05
India	1.25
Kenya	1.50
Nigeria	0.55
South Africa	1.29
USA	1.04

- In the case of transport, it is important to note that usually more can be attained (at lower cost) in terms of economic efficiency and reduced emissions by a shift in transport modes (i.e. from individual vehicles to public transport and, in the case of goods, from road haulage back to rail). A shift from cars to two (or three) wheelers would also bring efficiencies by reducing congestion, pollution and emissions.

7.1.2 Policies to Promote NEVs

Financing the transition

One problem is that purchasing costs remain high even though in many types of NEV, the total cost of ownership (TCO) is competitive or lower than ICE. In India, which maintains high tariffs on imports, the TCO for two- and three- wheelers is already significantly below that of ICE equivalents but the initial purchase price poses a problem. The same is likely to apply in Africa with the caveat that fuel prices are very low in some countries, as mentioned above.

Consumer subsidies can be used but fiscal constraints mean that these should be limited and should probably be phased down as technological advances reduce NEV prices leading to greater uptake. Conditions need to be set, for example, that subsidies only apply to locally produced vehicles or other NEV products. Smaller, lower cost vehicles should be targeted for equity reasons.

Other forms of financing such as subsidised lending are possible.

Taxes (e.g. carbon taxes) and rebates can be used to guide consumption behaviour. In South Africa ad valorem taxes on vehicles could be adjusted to favour EVs.

Promoting investment

Investments can be directly subsidised. In South Africa there already exist various forms of investment subsidies such as the Automotive Investment Scheme (AIS) for qualifying investment in the auto sector. Investments with public good characteristics such as charging facilities should be prioritised. A well-developed charging infrastructure will assist in the take up of EVs and can reduce the need for direct subsidies to consumers.

[40] Global Petrol Prices. 2024. https://www.iisd.org/articles/press-release/south-africa-fossil-fuel-subsidies-energy-crisis

The Critical Infrastructure Programme (CIP) aims to leverage investment by supporting infrastructure that is deemed to be critical, thus lowering the cost of doing business. For projects that alleviate electricity dependency on the national grid, the CIP offers a grant of 10% to 50%, up to a maximum of R50 million. The roll out of solar-powered charging infrastructure, could potentially qualify enabling the CIP to be leveraged to fund and promote business-to-government as well as business-to-business operations. The Automotive Industry Transformation Fund (AITF) could potentially be used to facilitate this. However the limited number of EVs on the road is currently a major impediment to private investment participation.

Regulation and standards

There are many forms of regulation that can promote the transition.

- Supportive (higher) import tariff policies are necessary. This is complicated by the fact that tariff protection raises costs and therefore slows the uptake of the product in question, for example electric vehicles. That said, encouraging domestic production will not easily happen without some protection. What is essential, however, is free continental trade and the fast tracking of automotive products within the AfCFTA.
- Adaptation of standards. In South Africa, for instance, regulations on the length of heavy vehicles need to be adapted to take account of the larger size of electric heavy trucks.
- Fuel economy standards could be strengthened.

Infrastructure

Charging facilities are key. Targets need to be clearly established and communicated to create confidence among international and domestic investors as well as consumers.

Innovative policies, strategies, and business models

There is considerable scope for innovation in all aspects of the promotion of the green transition. Some examples are provided below.

- Multilateral institutions, development banks and funding initiatives (e.g. the JET-IP) can partner with government and other financial institutions to provide blended finance, credit guarantees and preferential financing.
- Public procurement and the alignment of government tenders can work well for certain vehicle categories (e.g. buses) to create certainty and scale. An example is the bulk procurement of electric buses in India under FAME II and in Santiago, Chile.
- Financing batteries separately from the vehicle can reduce the upfront investment for buyers. Battery swopping can enable the development of business models that provide grid services using aggregated batteries.
- Prioritising pilot studies can encourage the development and implementation of innovative policies and business models. For example, ride hailing platforms could be used to experiment with NEVs.
- Commitments by major countries as well as stakeholders such as Afreximbank.
- Action to bring in multinational investors. Sometimes this would be undertaken purely by private firms and the stakeholder report illustrated a high potential for international partnerships for NEV component localisation in South Africa. But attracting international investors could involve coalitions of private sector players, government, multilateral finance institutions and development banks. It may be even possible to leverage Southern Africa's wealth in critical minerals in this regard.

Improved capacity for long term transport planning.

Better coordination between local metropolitan and national government is required. Comprehensive data is also necessary.

Table 6: Policy Recommendations for Two Wheelers in South Africa and Rest of Africa

Policy measure	Comment
Supportive infrastructure	This includes charging infrastructure but also most importantly urban infrastructure which facilitates and encourages two-wheeler transport. Dedicated cycle lanes which can be used by electric two wheelers are one example. Drastic measures that the Chinese took, such as the banning of ICE motorcycles in their major cities are not feasible in countries such as Africa. Targets for the roll out of charging infrastructure should be set.
The phasing down of fossil fuel subsidies	This would help increase the relative competitiveness of electric two- and three- wheelers especially in countries with very low petrol prices (e.g. Egypt and Nigeria).
Demand support	Small consumer support subsidies could play a role, as has been the case in India[41]. These were temporary but were important in reducing upfront purchasing costs. 53% of the three new wheelers purchased in 2022 were electric.[42] Support can be conditional on local production. Business models involving battery swopping, battery leasing and Battery-as-a-Service are particularly relevant for electric two- and three-wheelers and reduce upfront purchase costs.
Investment and production support	The assembly of two-wheelers can be viewed as an immediate opportunity for investment. More difficult is the domestic production of parts which generally require high volumes.
Public and fleet purchases	Retailers with large delivery fleets can begin to establish scale and could be incentivised to do so.
Achieving scale through export of motorcycle parts	Exports are essential to achieve optimal scale. It may be possible to have certain motorcycle component exports incorporated into the APDP so that they qualify for these benefits (see Annexure A).

[41] IEA. Transitioning India's Road Transport Sector, Chapter 4. 2023. https://iea.blob.core.windows.net/assets/06ad8de6-52c6-4be3-96fc-2bdc3510617d/TransitioningIndiasRoadTransportSector.pdf#page=57.09

[42] IEA. Transitioning India's Road Transport Sector, Chapter 4. 2023. https://iea.blob.core.windows.net/assets/06ad8de6-52c6-4be3-96fc-2bdc3510617d/TransitioningIndiasRoadTransportSector.pdf#page=57.09

7.2 Partnerships

As indicated above, what is being proposed is the building of a significant L-type vehicle industry in South Africa and the rest of Africa. This would be an addition to the already well-established light vehicle industry in SA. An increasing share of this new sector would comprise NEVs. It is noted that this transition is already underway in many countries. In China, the transition has, to a large extent, already taken place. In South Asia and Southeast Asia, it is well underway. In the developed world the transition is happening rapidly, especially within the EU.

7.2.1 Establish Shared Vision

It is important to establish a shared vision in South Africa and across the continent. Currently, there exists minor L-class assembly operations in South Africa and elsewhere. There is little in the way of a national or regional vision which pays much attention to L-type vehicle production. This is even though in 2022, Africa imported motorcycles to the value of $2.41 billion (excluding parts)[43]. The South African Automotive Masterplan (SAAM) envisions duty free importation of motorcycles into South Africa from the region and the rest of the world.

Establishing a shared vision would entail highlighting the potential for establishing production capacity for all L-type vehicles in South Africa and the region. A growing share of this capacity would comprise NEV's. This would need to be foregrounded in national policy documents as well as in the policy statements of the various regional organisations. It would also require the adoption of policies which are promotive to developing electric mobility within the L Class segment.

7.2.2 Industry Stakeholders

To capitalise on this market opportunity, comprehensive coordination between international, regional and national players is required. On the continent, this would be the AfCFTA Secretariat, the SADC and other regional organisations.

An important continental stakeholder in the industry is the African Association of Automobile Manufacturers (AAAM). The AAAM could play an important role. It has developed an Africa-wide strategy for the automotive industry and has concluded a number of automotive pacts involving South Africa, Côte d'Ivoire, Ghana and Kenya. Naturally, the automotive industry tends to concentrate in clusters. The AAAM has developed a 'hub and spoke' strategy in which vehicle assembly takes place in the 'hub' countries and the surrounding 'spoke' countries are involved as suppliers. Up to now, relatively little attention has been paid to two- and three-wheel vehicles. The establishment of a two- and three-wheeler sector across the continent would open up opportunities for the creation of additional production centres and more countries involved. This should facilitate negotiations on regional integration.

In South Africa, the most important stakeholders are the industry associations NAAMSA and NAACAM. Local and international companies naturally play an important role (see below). Additional capital could be provided by institutions such as the DFI's, Afreximbank and through the JET-IP process.

7.2.3 Identification of Potential International Investment Partners

Currently there are a significant number of small-scale initiatives in South Africa and the rest of Africa as set out in Annexure C: Case Studies.

What is needed are larger scale anchor investments. These would initially probably consist of ICE two-wheeler investments in South Africa and elsewhere on the continent. The advantages of establishing even a medium-sized motorcycle assembly plant, producing more than 100,000 motorcycles a year[44] are very significant as

[43] Trade statistics | ITC (intracen.org)
[44] Honda's largest plant globally in Karnataka, India has an annual capacity of 2.4 million motorcycles per annum.

they would start to provide the scale required to localise components production. Part of these larger-scale plants could cater for electric L-class production.

Potential international partners would include the major Indian, Chinese or Japanese producers. India is currently the largest motorcycle exporter globally with Bajaj Auto being the largest exporting firm followed by TVS Motor Co. There are also possibilities for joint ventures with local firms.

7.2.4 Value Proposition

The value proposition is a large and growing national and continental market for conventional L-class vehicles which is starting to transition to electric power. This industry will be facilitated by growing regional integration made possible by the further development of the AfCFTA. It is, therefore, possible to foresee the development of a significant regional automotive value chain in which South Africa plays a key role, but which incorporates many other countries across the continent.

India provides an interesting comparison with Africa. With comparable economic size and GDP per capita, both India and Africa have large motorcycle markets. The contrast is in production and trade. India is the world's largest exporter of motorcycles. Africa on the other hand is a large net importer. A key difference, of course, is that India comprises a single integrated market. That is not yet the case in Africa although progress is being made.

7.2.5 Engagement

Engagements would include with the South African government it's various agencies and industry stakeholder groups. It would also be necessary to engage with regional countries including governments and various stakeholder groups.

One strategy that could be pursued would be to target specific multinational producers such as Indian multinationals, TVS and Bajaj or indeed Japanese or Chinese multinational firms. Establishing anchor investments in a few locations on the continent could play a key role in establishing a significant two- and three-wheeler manufacturing capacity on the continent. Initially these may be to produce ICE rather than electric motorcycles or three-wheelers. Large scale investment in electric two or three wheelers is currently constrained by the prevailing underdeveloped market and ecosystem. But establishing a motorcycle industry even comprising conventional technology would help lay the ground for a parallel expansion of electric two- and three-wheeler production.

This could happen via the establishment of large-scale assembly which in turn would attract investment in the supply chain by domestic and multinational firms. Many of these components could be used by both ICE and electric vehicles.

Large scale domestic assembly would also create a regional market for the batteries required in L-class vehicles. In addition, it would further the case for battery swapping and battery charging facilities.

Another reason for pursuing a regional strategy and regional collaboration, for example via the AfCFTA, is to try and develop continental industry standards from an early stage. This will undoubtedly be a complex task but the sooner such processes are put in place the greater the impact that can be achieved.

7.2.6 Knowledge and Skills

A strategy needs to be developed which incorporates both research and skills development. This would entail bringing skills and technical know-how into SA but also providing skills and assistance to countries in the region. Fortunately, South Africa can draw on extensive experience in automotive manufacturing. But the skills needed for producing batteries, electric motors, control systems etc. would need to be developed. An example here is the TVET strategic framework proposals developed to produce equipment required by the emerging green hydrogen sector.45

8. OPPORTUNITY IDENTIFICATION

The methodology of this report includes an examination of the NEV ecosystem, focussing on identifying opportunities within the value chains of L-class electric vehicles (two-, three- and four-wheelers).

The aim of this section is to identify and prioritise components of these vehicles that have potential for competitive production in South Africa. To achieve this, a systematic approach using a selection strategy and an evaluation matrix system is utilised. This process includes an assessment of the capabilities and gaps in the South African manufacturing landscape and identifies opportunities for investment in the NEV value chains.

By initially focusing on L-class electric vehicles, this methodology aims to lay the foundation for broader localisation efforts within the South African NEV industry.

8.1 Value Chains

Four primary value chains play a role in shaping a NEV ecosystem in South Africa. Firstly, the realm of electric L-class vehicles includes a diverse array of two-, three--, and four-wheelers, representing the forefront of eco-friendly transportation innovation. These vehicles, powered by electric motors, are pivotal in reducing carbon emissions and fostering cleaner urban mobility solutions such as last-mile delivery services.

Secondly, NEV charging infrastructure forms the backbone of electric mobility, providing the necessary infrastructure for recharging electric vehicles conveniently and efficiently. With a growing emphasis on electrification, the development of robust charging networks is crucial for promoting widespread adoption of NEVs. This report focuses on charging infrastructure used by commercial L-class vehicles such as last-mile delivery services.

Thirdly, batteries stand as a cornerstone in the NEV value chain, the integration of battery technologies is essential for powering electric vehicles. As the demand for electric vehicles surges, establishing South Africa's battery value chain capabilities becomes important for ensuring supply chain resilience and reducing dependency on imports. A report by the World Bank Group[46] stated that Lithium-ion battery (LIB) chemistries will continue to be the dominant battery technology by 2030, therefore the value chain focuses on Lithium-Ion batteries.

Finally, battery recycling emerges as a component in the sustainability of NEV ecosystems, addressing the end-of-life management of lithium-ion batteries and minimising environmental impacts through responsible disposal and material recovery. The establishment of battery recycling facilities contributes to circular economy principles, conserving resources and mitigating environmental pollution.

These four interconnected value chains collectively drive the evolution of South Africa's NEV industry, shaping a future of sustainable mobility and environmental stewardship.

[45] Saiia. 2022. https://saiia.org.za/wp-content/uploads/2022/06/SAIIA_SR_GreenHydrogenTVet.pdf
[46] World Bank, 2023. Link: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099155502102332395/pdf

8.1.1 Electric L-Class Vehicle Value Chain

The value chain for electric L-class vehicles consists of three main value streams: upstream, middle stream and downstream. Figure 17 below is an electric L-class vehicle value chain for South Africa and Africa.

Short-term opportunities (probable to appear in less than 5 years) for localisation and investment are highlighted in green, medium-term opportunities (with approximate investment opportunities between 5 to 10 years) are highlighted in yellow, opportunities that need more time, planning and investment which can become a likely opportunity in approximately 10 years-time, are highlighted in orange and opportunities that already exist in South Africa are highlighted in blue.

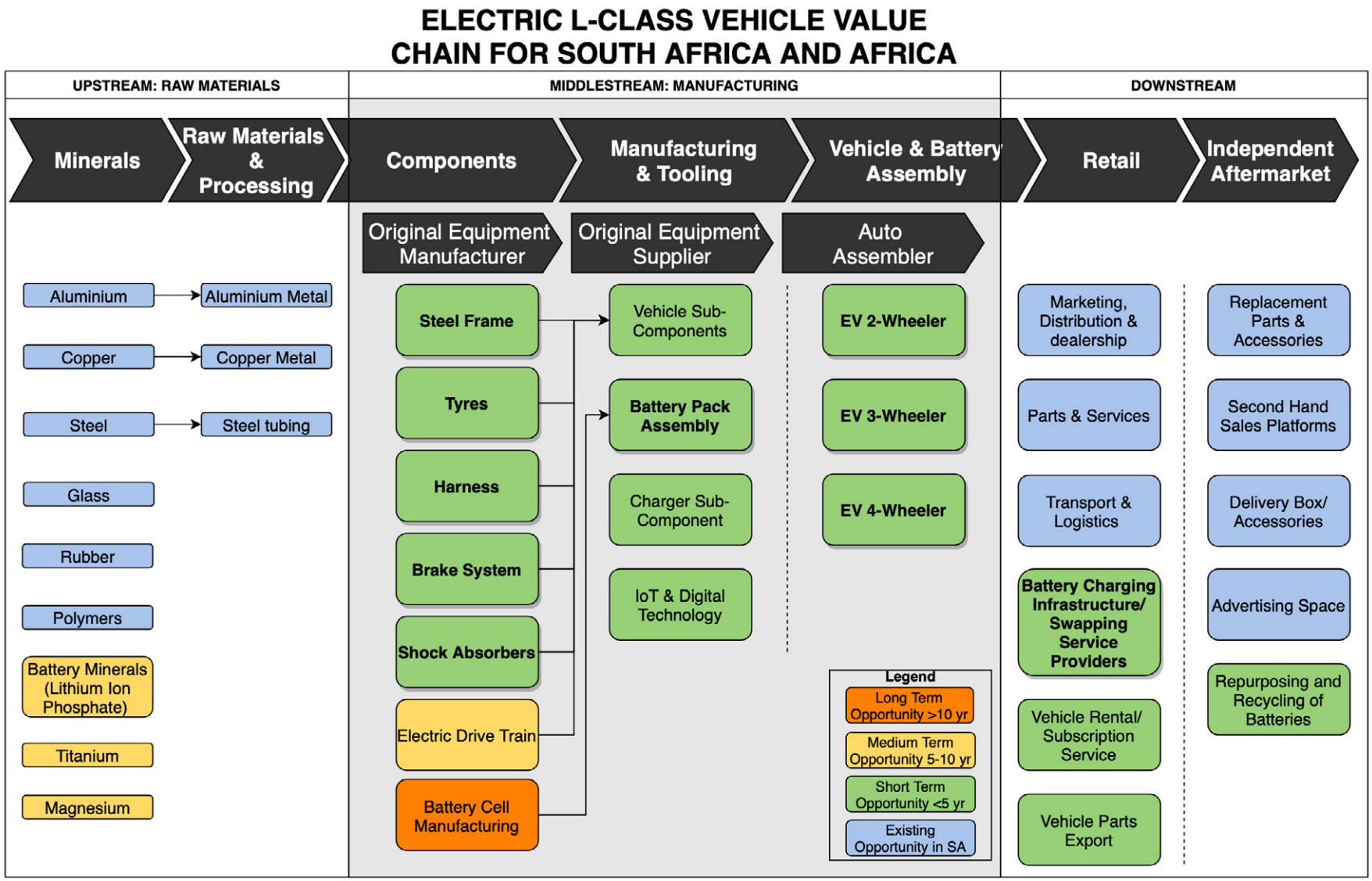


Figure 15: EV 2/3/4-Wheeler Value Chain for South Africa and Africa

Upstream

The first value of steam mainly includes raw materials and the processing thereof. Many raw materials used in the electric L-class value chain are already being sourced and processed in South Africa and Africa. These raw materials include aluminium, copper, steel, glass, rubber and polymers[47]. Raw materials in this value chain that are not in South Africa includes magnesium and titanium. $LiFePO_4$ battery raw materials are available in Southern Africa, and with investments in the pipeline by the IDC, $LiFePO_4$ battery mineral sourcing and processing will be operational by 2030, which is why the value chain above reflects this opportunity in yellow.

Middle Steam

The middle stream includes manufacturing and assembly which is mainly done by OEMs. This value chain aims to show that there is a high possibility of local manufacturing of components such as steel frames, harnesses, tyres, brake systems and shock absorbers. It is important to note that a significant number of components are used for both ICE and electric vehicles, this gives the components manufacturing an economy of scale advantage which is vital for the economic feasibility of local components manufacturing.

Another vital part of this value stream and a likely investment opportunity for South Africa, is to locally assemble battery packs for the electric L-class vehicles. An interesting note on battery pack assembly is that Green Riders E-Bicycle Company) assemble their own battery packs. The value chain above highlights battery pack assembly in green because although South Africa technically has an existing battery pack assembly for two-wheelers, the volumes are still low.

The final step in the middle value stream is to locally assemble the L-class vehicles which include assembly of two-, three-, and four-wheelers which could be done by OEMs. The automotive value chain is a producer-driven value chain in which the production and retail of vehicle sales are governed by the OEMs[48]. They have the power to shape the value chains through the scale and specification of their orders. Inevitably, vehicle manufacturing complexity is highly capital intensive, and the economics of the sector are therefore driven by economies of scale[49].

Downstream

This value stream includes retail and independent aftermarket opportunities. The most important part to ensure a functioning NEV ecosystem is charging infrastructure and battery swapping service providers. The downstream applications are already successfully established for the ICE vehicles; electric vehicles have the potential to form a natural extension for retail and aftermarket businesses, therefore most downstream opportunities are highlighted in blue. OEMs also typically provide aftermarket services to customers[50]. They do this through well-developed dealer networks that provide high-value commercial opportunities to national investors.

8.1.2 Charging Infrastructure Value Chain

The value chain for charging infrastructure for electric L-class vehicles consists of three main value streams: upstream, middle stream and downstream. Figure 18 below is an electric L-class vehicle value chain for South Africa and Africa.

Short-term opportunities (probable to appear in less than 5 years) for localisation and investment are highlighted in green, medium-term opportunities (with approximate investment opportunities between 5 to 10 years) are highlighted in yellow, opportunities that need more time, planning and investment which can become a likely opportunity in approximately 10 years-time, are highlighted in orange and opportunities that already exist in South Africa are highlighted in blue.

[47] Department of Mineral Resources. 2014/2015. https://www.dmr.gov.za/LinkClick.aspx?fileticket=z2XyeVTH7RE%3D&portalid=0
[48] AIEC. Localisation and export development matrix 2017-2020.
[49] AIEC. Localisation and export development matrix 2017-2020.
[50] AIEC. Localisation and export development matrix 2017-2020.

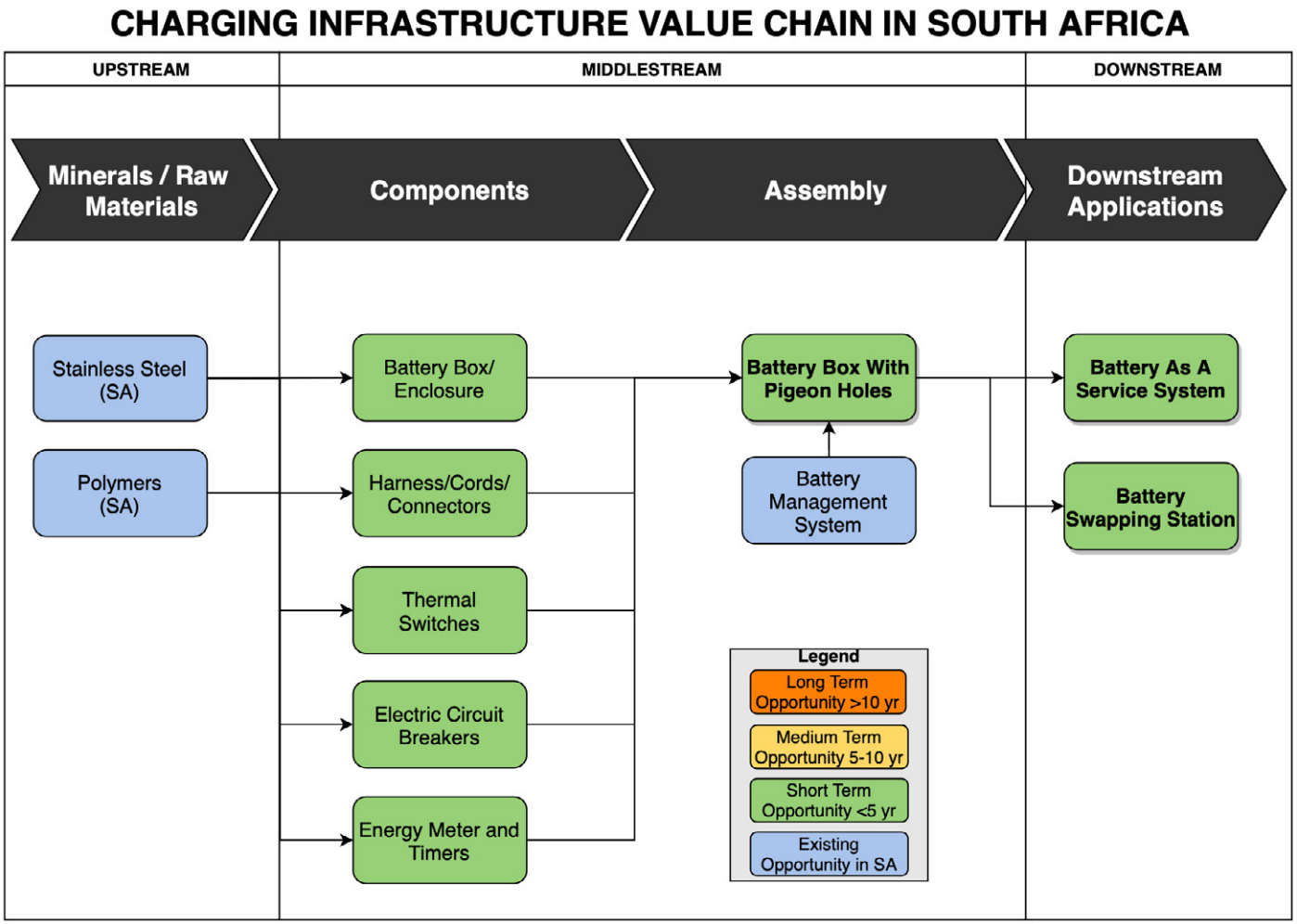


Figure 16: Charging Infrastructure Value Chain in South Africa

Upstream

Upstream opportunities for the charging infrastructure value chain that already exists in South Africa include sourcing and processing of stainless steel and polymers.

Middle Stream

Opportunities for the middle-value stream showcase the likeliness for local manufacturing of components such as battery enclosure, harnesses, switches, circuit breakers and times. The assembly of these battery boxes with pigeonholes for the battery swapping stations is another likely, short-term opportunity for South Africa. Battery management systems technology is already available in South Africa and is therefore highlighted in blue.

Downstream

Battery as a service (BaaS) and battery swapping stations are key parts of the charging infrastructure to be developed and implemented in South Africa. The battery-swap service is the infrastructure needed to make electric mobility a viable transport alternative[51].

8.1.3 Lithium-Ion Battery Value Chain

The Lithium-ion battery (LIB) value chain for South Africa consists of three main value streams: upstream, middle stream and downstream. Figure 19 below is an electric L-class vehicle value chain for South Africa and Africa. Short-term opportunities (probable to appear in less than 5 years) for localisation and investment are highlighted in green, medium-term opportunities (with approximate investment opportunities between 5 to 10 years) are highlighted in yellow, opportunities that need more time, planning and investment which can become a likely opportunity in approximately 10 years-time, are highlighted in orange and opportunities that already exist in South Africa are highlighted in blue.

[51] McKinsey & Co. 2022. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/power-to-move-accelerating-the-electric-transport-transition-in-sub-saharan-africa#/

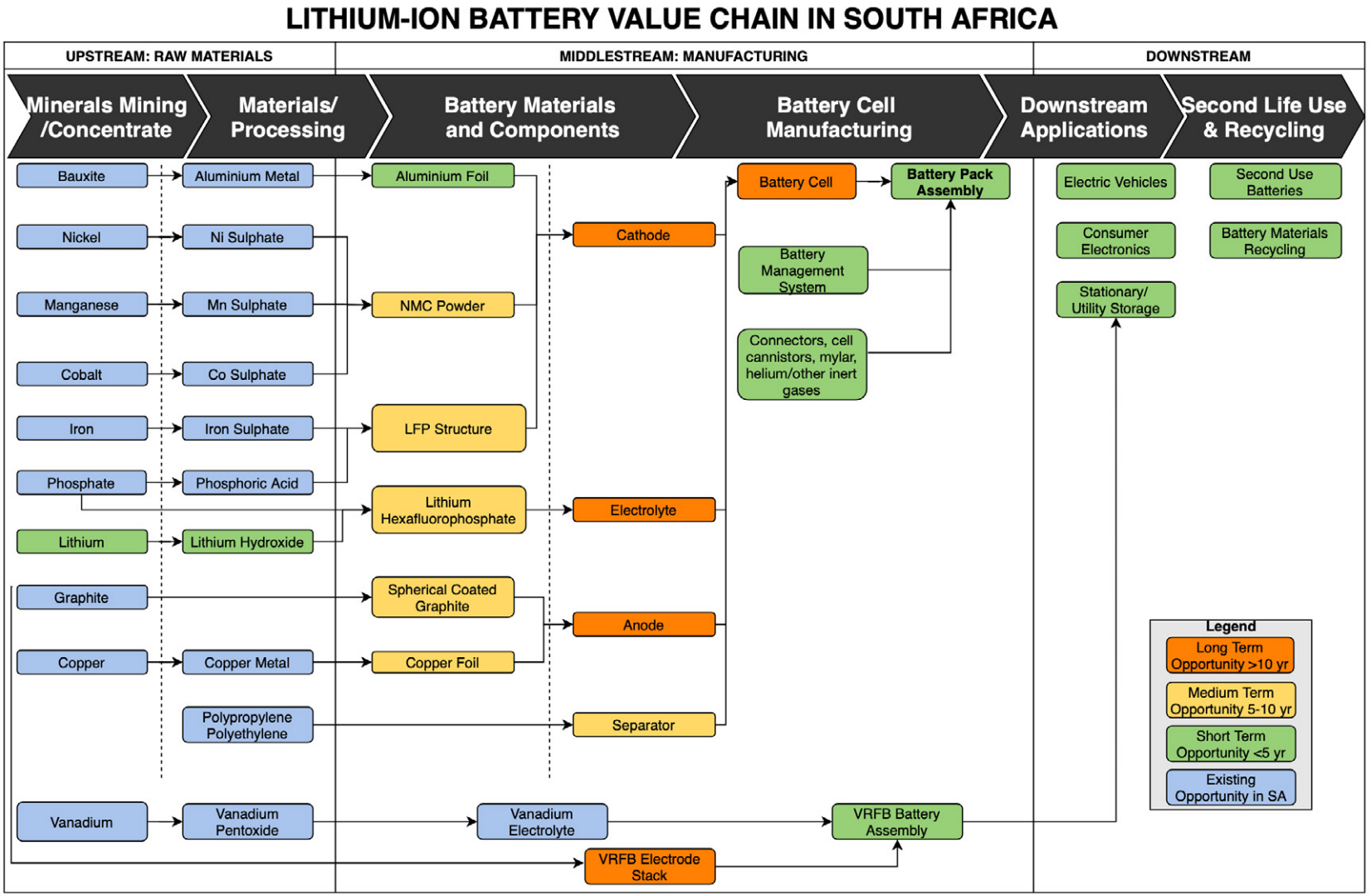


Figure 17: Li-ion Battery Value Chain in South Africa

Upstream

Many raw materials for the LIB value chain are mined in the sub-Saharan region of Africa. A likely opportunity for Lithium ore sourcing and processing exists in Namibia and Zimbabwe [52]. South Africa holds about 78% of the world's manganese[53]. South Africa, however, has a small share of beneficiated manganese, e.g., ferromanganese[54]. Most mineral beneficiation is currently happening in Asia, which provides up to 97% of the current global LIB demand[55].

The logistical advantages of closer geographical proximity, coupled with improved regional free trade policies, such as the African Continental Free Trade Area (AfCFTA), the African Union (AU) Agenda 63, and the SADC Industrialisation Strategy and Roadmap (SISR), which provide a framework to fast-track the participation of member states in global value chains, could offer a range of advantages in accessing and utilising these raw materials. While the Rules of Origin for the auto sector remain a stumbling block in the AfCFTA negotiations, it should be possible to reach an agreement on batteries for automotive applications. Batteries (not specifically automotive) are one of the products selected under the AfCFTA's Guided Trade Initiative (GTI), which seeks to promote meaningful trade under the agreement[56].

Middle Stream

The value chain highlights the opportunity to start localisation by investing in local battery pack assembly. Batteries are the key component of an EV, making up about 20%-25% of the battery electric vehicle's value as battery prices in China have declined significantly to $53/kWh in 2024[57].

The local battery value chain has mostly developed through the private sector, with little to no financial support from the public sector. Currently, there are there are several Lithium battery assemblers in South Africa. These include Freedom Won, Solar MD, Blue Nova, Balance Cell and REVOV. Thus, providing an opportunity for future assembly and potential manufacturing for South Africa and the wider Southern African regions.

South Africa currently has no local commercial production of battery cells and relies on assembling imported cells. This is likely to continue being the case until a significant scale is reached, providing demand and a business case for LIBs. The University of the Western Cape only has a pilot plant used for research and development purposes and to assess economic viability[58]. A Multi-Model Battery Pack assembly plant that supplies batteries for OEMs might be seen as a long-term opportunity in the battery value chain. By manufacturing batteries for multiple OEMs, it might be possible to reach economies of scale and reduce costs.

The cost of a LIB battery pack comprises cell materials (34%), pack materials (27%), capital costs (24%), and operating costs (15%). Sufficient volumes to create economies of scale would be required for the financial viability of setting up such plants[59].

Multiple local battery companies are involved in offering BMS hardware, technologies and software for various applications in the local market[60].

Downstream

There is a vast field of downstream applications for LIB in South Africa, which include LIB for electric vehicles, energy storage systems such as batteries for solar farms as well as batteries used for consumer electronics. To support a self-sustaining ecosystem, it is also important to utilise second life and recycling opportunities for LIB.

[52] Statista. 2023. https://www.statista.com/statistics/1051511/zimbabwe-lithium-production/
[53] Greencape. 2021. https://greencape.co.za/assets/The-Electric-Vehicle-Ecosystem-and-Associated-Value-Chains.pdf
[54] Greencape. 2021. https://greencape.co.za/assets/The-Electric-Vehicle-Ecosystem-and-Associated-Value-Chains.pdf
[55] Greencape. 2021. https://greencape.co.za/assets/The-Electric-Vehicle-Ecosystem-and-Associated-Value-Chains.pdf
[56] The AfCFTA Guided Trade Initiative - AfCFTA (au-afcfta.org)
[57] https://www.bloomberg.com/news/newsletters/2024-07-09/china-s-batteries-are-now-cheap-enough-to-power-huge-shifts
[58] Greencape. 2021. https://greencape.co.za/assets/The-Electric-Vehicle-Ecosystem-and-Associated-Value-Chains.pdf
[59] TIPS. 2021. https://www.tips.org.za/images/Battery_Manufacturing_value_chain_study_main_report_March_2021.pdf
[60] TIPS. 2021. https://www.tips.org.za/images/Battery_Manufacturing_value_chain_study_main_report_March_2021.pdf

8.1.4 Battery Recycling Value Chain

The value chain for battery recycling consists of three main value streams: upstream, middle stream and downstream. Figure 20 below is an electric L-class vehicle value chain for South Africa and Africa.

Short-term opportunities (probable to appear in less than 5 years) for localisation and investment are highlighted in green, medium-term opportunities (with approximate investment opportunities between 5 to 10 years) are highlighted in yellow, opportunities that need more time, planning and investment which can become a likely opportunity in approximately 10 years-time, are highlighted in orange and opportunities that already exist in South Africa are highlighted in blue.

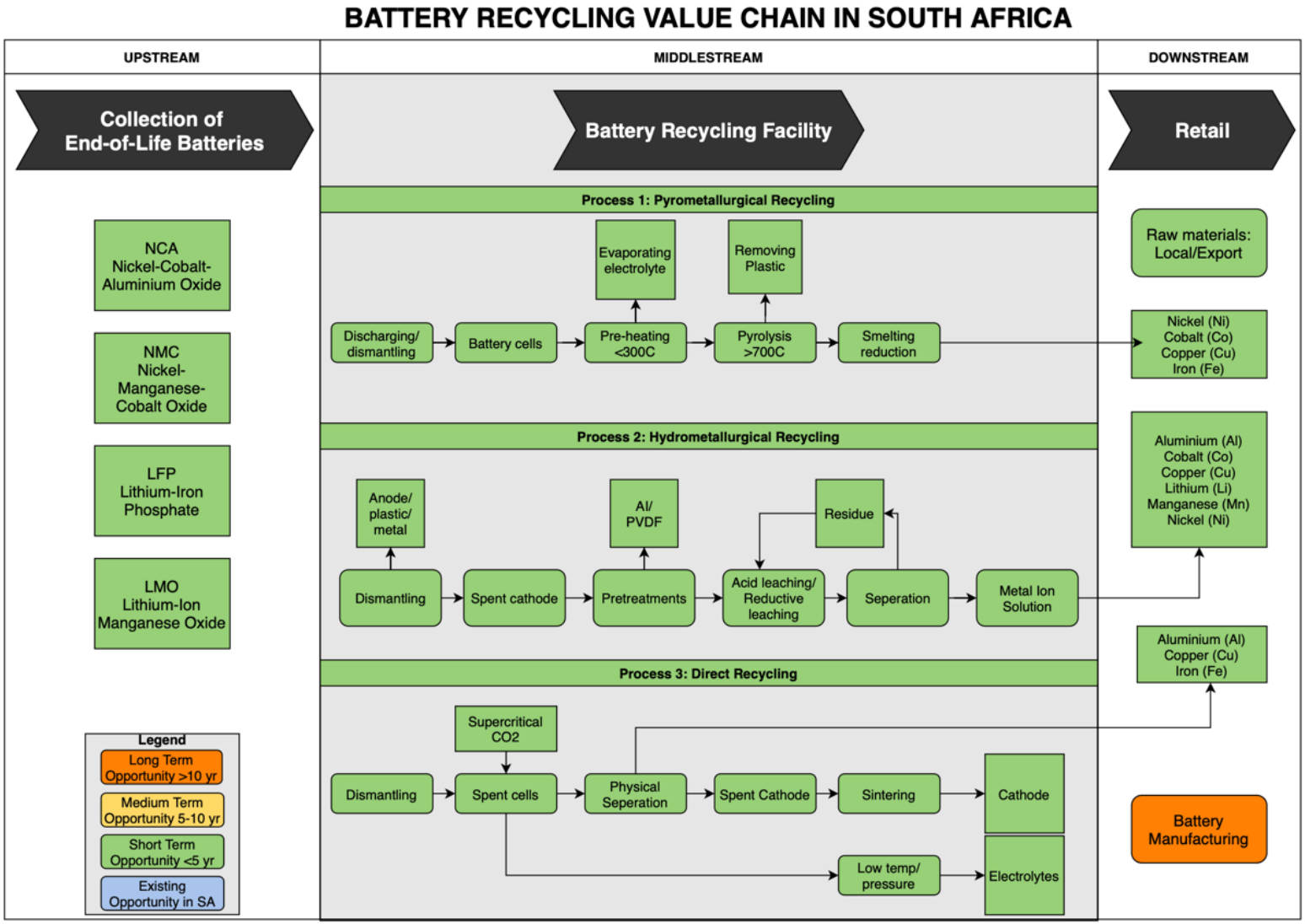


Figure 18: Battery Recycling Value Chain in South Africa

Upstream

Collection of end-of-life batteries is a vital step in the battery recycling value chain. Types of batteries to consider for recycling include NCA, NMC, LFP and LMO.

Middle Stream

The aim of this value chain is to utilise the recycling plant for batteries as an opportunity. There are many different processes for recycling LIB batteries. In this value chain, the pyrometallurgical, hydrometallurgical and direct recycling processes are emphasised. The extraction of the various mineral components of a battery has proven difficult and costly in the past, and recent research has focussed on ways to reuse cathodes and other mineral battery components. South Africa also has the technical capability to establish these processes locally.

There is no facility in South Africa that commercially recycles lithium-ion batteries. Due to the 2020 Extended Producer Responsibility (EPR) regulations issued by the Department of Environment, Forestry and Fisheries (DEFF), which prohibit the disposal of e-waste in landfills, the batteries (for electric and hybrid vehicles) are either stored or shipped abroad for recycling or disposal. Although the South African EPR regulations are quite advanced compared to the standards of developing countries, implementation remains a problem. For example, there remains a huge problem of disposal of smaller lithium batteries in landfill sites.

Downstream

The retail part of the battery recycling value chain includes the export and local trading of the recycled raw materials.

8.2 High-Level Opportunity Scoring Matrix

A high-level opportunity scoring matrix in Table 7 presents a strategy for identifying key components to localise first within the four value chains. By assessing capabilities within South Africa and pinpointing gaps in the value chains, this matrix illuminates investment opportunities. Through a scoring system, components with elevated scores emerge as candidates for localisation within South Africa, thereby laying the groundwork for a competitive edge in the global EV market.

The criteria for the scoring matrix are defined as follows:

Projected Demand

Projected/perceived demand refers to the estimated future quantity of a product or service that will be required by consumers within a specified period. The scoring criteria favours, short-term (less than 5 years) projected demand and high-demand products, for localisation to be competitive.

Economic Potential

Economic potential refers to the capacity of an investment opportunity to generate economic value, including factors like revenue generation, profitability, market growth, and overall economic impact. Incorporating economic potential into the investment opportunity scoring matrix ensures a comprehensive evaluation, aligning investments with strategic economic goals and maximising returns. For the scoring exercise, the larger the investment needed to set up, the higher the economic potential was scored.

Job Creation Potential

Job Creation Potential refers to the capacity of an investment opportunity to generate employment opportunities, both directly and indirectly, within a specific timeframe and region. This potential includes the creation of new jobs, the enhancement of existing positions, and the contribution to workforce development. Including job creation potential in an investment opportunity scoring matrix ensures a holistic assessment, highlighting investments that contribute significantly to socio-economic development and sustainable growth.

Current Capability

Current capability refers to the existing capacity, proficiency, and readiness of local industries to manufacture products that meet specified standards, including quality, safety, and production requirements set by OEMs. Including current capability in an investment opportunity scoring matrix ensures that investments are directed towards ventures with the technical and operational capacity to meet industry standards and achieve successful outcomes.

International Partners

International Partnerships refer to collaborative agreements between local industries and foreign companies, organisations, or entities aimed at achieving mutual business objectives. These partnerships can include joint ventures, strategic alliances, technology transfer agreements, and other forms of cooperation that leverage the strengths and resources of both parties. Including international partnerships in an investment opportunity scoring matrix ensures that investments are evaluated for their potential to enhance local industry capabilities, expand market reach, and achieve sustainable growth through strategic global collaborations.

Support Industries

Support Industries refer to the network of local suppliers and manufacturers that provide raw materials, sub-components, and other inputs necessary for production processes in the automotive industry. Including support industries in an investment opportunity scoring matrix ensures a comprehensive evaluation of the local supply chain's strength and its ability to contribute to efficient, cost-effective, and sustainable production processes.

OEM Support

The chosen component to investigate must have the potential to become a component that the OEM would consider buying to support its production and export strategy. This standard of component must meet the stringent OEM requirements and price. The quality, volume and supply strategy must be robust and have a proven track record before being considered by any OEM.

Local Partners

The component of choice is evaluated against similar component suppliers in South Africa, who could provide support, advice, skills or business synergies to start the component manufacture.

From Table 7 below it is clear that the opportunities that score the highest are L-class vehicle manufacturing and assembly, battery pack assembly as well as charging infrastructure provision. L-class vehicle components that score the highest as seen in the matrix are tyres, steel frame, harness, shock absorbers, brake systems and battery pack. These components are prime candidates for localisation within South Africa. To industrialise the manufacturing of these components, economies of scale are required. It is therefore important to consider the manufacturing of components that are common parts for both ICE and electric L-class vehicles.

A detailed reasoning behind each of the scores is presented in Table 13, Table 14, Table 15 and Table 16 in Annexure B: Opportunity Scoring Matrix.

South Africa's current capabilities and environment support the high-scoring opportunities and components. These opportunities have a high potential of localisation and are therefore considered as opportunities for investment in the next sections of the report.

Table 7: Opportunity Scoring Matrix

Opportunity Scroring Matrix											Score Legend: 1-LOW 5-MEDIUM 10-HIGH
	Criteria										
Opportunity / Component	**Projected Demand (<5 yrs)**	**Economic Potential**	**Job Creation Potential**	**Current Capability**	**International Partners**	**Support Industries**	**OEM Support**	**Local Partners**	**Total**	**Average**	
Opportunity											
L-class Vehicle Manufacturing and Assembly	9	7	8	10	7	10	6	8	**65**	**8,13**	
Charging Infrastructure Provision	9	6	5	9	8	9	6	8	**60**	**7,50**	
Battery Cell Manufacturing	7	8	7	1	5	3	5	3	**39**	**4,88**	
Battery Pack Assembly	8	6	8	9	8	6	5	9	**59**	**7,38**	
Mining and Benefication of Battery Minerals	8	8	8	7	8	6	5	7	**57**	**7,13**	
Battery Recycling Facility	6	5	7	5	5	4	5	5	**42**	**5,25**	
Component											
Steel Frame	8	7	9	10	9	10	9	9	**71**	**8,88**	
Tyres	9	8	9	9	9	10	9	9	**72**	**9,00**	
Brake System	8	6	7	6	6	10	8	8	**59**	**7,38**	
Shock Absorbers	8	6	7	7	6	10	8	8	**60**	**7,50**	
Harness	6	6	9	8	8	10	9	9	**65**	**8,13**	
Battery Cell	6	9	7	1	5	3	5	3	**39**	**4,88**	
Battery Pack	8	6	8	9	8	6	5	9	**59**	**7,38**	

9. OPPORTUNITY FEASIBILITY SCOPING

In the previous section, we outlined the possibilities for L-class vehicles. In this section, these opportunities are quantified to assess the ability to achieve economies of scale.

A triangular research approach was used to model demand and determine the feasibility of the opportunities presented in this report. The triangular approach was based on: (1) data from recent literature studies and industry reports, (2) import and trade statistics from the ITC website, and (3) various interviews with stakeholders to gain an understanding of the current and future market.

*Demand modelling and feasibility scoping was conducted based on publicly available data. AIH therefore cannot vouch for the accuracy of the information as some data may be understated. To ensure consistency, the same references and websites were used throughout the market study.

9.1 Demand for ICE Motorcycles

Based on available literature and import statistics from the ITC website[61], an assessment of the African motorbike market was made, which is shown in the following table for the year 2022. The import demand for motorcycle in Africa is estimated at 1.4 million units in 2022 at a value of USD2.5 billion.

[61] ITC. https://intracen.org/resources/data-and-analysis/trade-statistics

Table 8: Motorcycle Demand in Africa (2022)

ICE Motorcycles	GDP US$ Billion	Per capita GDP US$	2022 US$	2022 Units
Egypt	398	3,770	52,760,000	32,975
Nigeria	390	1,755	1,244,659,752	691,478
South Africa	381	6,191	109,013,000	27,253
Algeria	224	4,875	51,024,000	31,890
Ethiopia	156	1,473	55,665,000	34,791
Morocco	147	3,980	108,826,000	68,016
Kenya	113	2,188	150,100,000	93,813
Angola	94	2,550	77,100,000	48,188
Tanzania	84	1,327	154,626,000	96,641
Ghana	77	2,329	52,500,000	32,813
Uganda	52	1,163	156,613,000	97,883
Senegal	31	1,715	16,393,000	10,246
Zambia	30	1,436	9,039,000	5,649
Rest of Africa	692		706,837,501	428,864
TOTAL	**2869**		**2,487,020,836**	**1,412,928**

The above table reflects the concentration of motorcycles in East Africa and Nigeria as opposed to South Africa and Egypt that are amongst the top 3 economies on the continent. The two-wheeler market in Nigeria is the same size as the estimated new vehicle sales in Nigeria (estimated at USD1.4 billion per annum), clearly indicating its economic contribution.

9.2 Demand for Electric Two-Wheelers

The current market for electric two-wheelers in Africa and South Africa is limited. Total imports amounted to just $33,7 million in 2022, but this was almost double the previous year and went up from $9.7 million in 2018. South Africa dominates electric two-wheeler imports into Africa, accounting for almost half of the total imports in 2022. Costs are a key factor in accelerating the transition.

Table 9: Electric Motorcycle Demand in Africa (2022)

ICE Motorcycles	GDP US$ Billion	Per capita GDP US$	2022 US$	2022 Units
Egypt	398	3,770	574,000	319
Nigeria	390	1,755	217,000	181
South Africa	381	6,191	17,382,000	4,966
Algeria	224	4,875	34,000	24
Ethiopia	156	1,473	478,000	341
Morocco	147	3,980	6,961,000	3,867
Kenya	113	2,188	690,000	575
Angola	94	2,550	51,000	43
Tanzania	84	1,327	330,000	273
Ghana	77	2,329	80,000	44
Uganda	52	1,163	24,000	13
Senegal	31	1,715	33,000	18
Zambia	30	1,436	67,000	37
Rest of Africa	692		6,830,250	2,595
TOTAL	**2869**		**33,751,250**	**13,300**

**Key assumptions used in determining the African market for electric 2-wheelers, included various publications and analysis of several country import statistics from ICT database.[62] Import data for fully assembled 2-wheelers were considered for the model.*

Electric motorcycles and scooters have been the most popular EV choice for retailers in Africa, making up 75% of available electric two and three-wheel models, yet total uptake remains low. A lack of financing for e-motor cycle importers and limited charging and swapping infrastructure has dampened deployment. Currently, there are less than 20 000 electric motorcycles deployed in Africa, or less than 0.5% of the entire motorcycle fleet on the continent – but growth is accelerating.

Traditionally, the rate of electrification has been under 5% across all major two-wheeler markets with the important exception of China where it is much higher, approximately 15%. Obstacles to growth in electric vehicle adoption for the African markets include higher acquisition costs, limited product options from incumbents, and the lack of finance and charging ecosystems. However, most of these issues are being addressed such as the significant improvements in battery technology, (electric two-wheelers are no longer

[62] ITC. https://intracen.org/resources/data-and-analysis/trade-statistics

limited by range), and as the scale of manufacture increases, the price differential decreases leading to the TCO of electric two-wheelers being on par with (and better than) ICE vehicles in many regions.

A recent report from McKinsey indicates that two-wheelers will electrify fastest, with electric two-wheeler sales rising to 50% to 70% of global sales by 2040. In Kenya and Nigeria alone—two of the largest two-wheeler markets in sub-Saharan Africa- would translate into 3 million to 4 million electric two-wheeler sales per year by 2040.63 The McKinsey report states that by 2040, the demand for electric two-wheelers in Africa will be over 3 million pa.64 South Africa is currently experiencing a rapidly expanding segment in the 'last mile delivery market' that requires a service that will deliver goods (mostly food and household items) to customers.

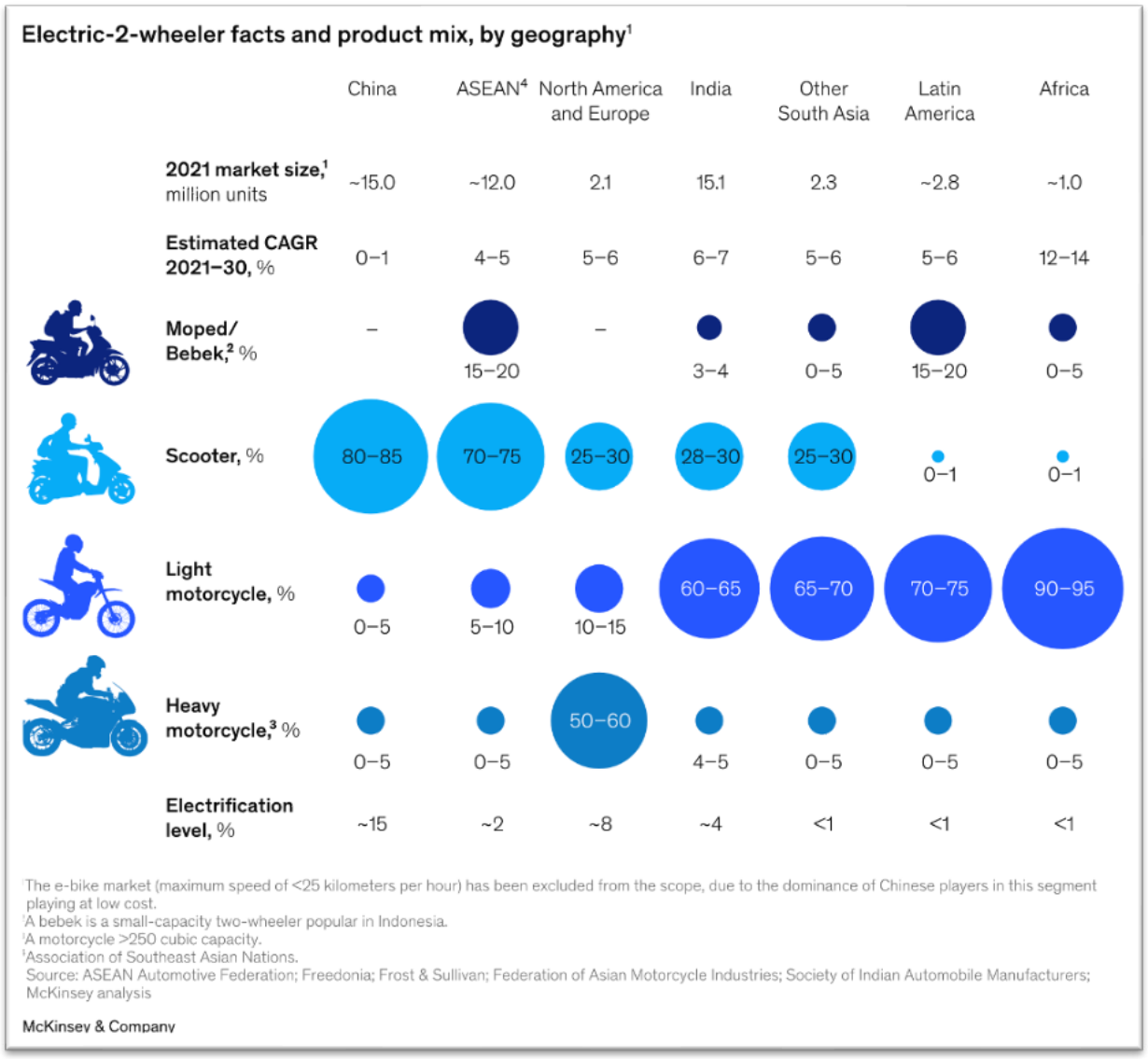


Figure 19: Electric-2-Wheeler Facts and Product Mix, by Geography[65]

From McKinsey's report and the figure above, the greatest growth in the light motorcycle segment is expected in Africa. This presents a big opportunity for South Africa to become a high-technology manufacturing base of the complete package of components (CKD kit) for export and motorcycle assembly elsewhere in Africa.

[63] McKinsey & Co. 2022. Power To Move. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/power-to-move-accelerating-the-electric-transport-transition-in-sub-saharan-africa
[64] McKinsey & Co. 2021. Green Africa. https://www.mckinsey.com/capabilities/sustainability/our-insights/green-africa-a-growth-and-resilience-agenda-for-the-continent
[65] McKinsey&Co. 2023. The real global EV buzz comes on two wheels. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-real-global-ev-buzz-comes-on-two-wheels#/

9.3 Demand for Electric Three-Wheelers

When examining the global OEM marketplace, it is crucial to acknowledge that four wheels are not always the best. In several regions, such as APAC, Latin America, and Africa, two- and three-wheelers (2W and 3W) prevail due to affordability, manoeuvrability, and fuel efficiency.

- In Tanzania Internal combustion 3-wheelers are one of the main modes of transport. There are an estimated 250,000 ICE 3-wheelers in Tanzania, and a local company TRí wants to lead the transition of this 3-wheeler sector to electric. TRí started commercial operations in October 2022 after researching on which type of 3-wheeler would make sense in this environment, market, and specific use cases[66].
- Uganda has recorded 3-wheeler sales for the first time in 2021 and the growing popularity of 3-wheelers is taking market share from 2-wheelers.

The global OEM marketplace is adapting to regional preferences for two and three-wheelers, particularly in APAC, Latin America, and Africa[67]. These vehicles offer practical and economic benefits, with electric models on the rise. Brands are innovating to meet local needs, promising a future where e2W and e3W options could lead to urban transportation solutions.

The three-wheelers market is driven by demand elements such as, the rise in the need for reasonably priced commercial vehicles, the need for electric passenger and load carriers, and the low maintenance and production costs.

9.3.1 The Adoption of Electric Three-Wheelers

To surpass Uber, the taxi industry giant Ola introduced an entire fleet of Bajaj and Piaggio autorickshaws in the Liverpool area in March 2019. Like the cost of ownership for electric 2-wheelers, the relatively higher operating and maintenance costs of petrol/CNG & diesel propelled 3-wheelers are leading to a shift in preference for electric 3-wheelers for shorter transits. Since 3-wheelers provide outstanding agility at a reasonable price, many businesses in the e-commerce, pharmaceutical, textile, retail, FMCG, and other utility categories, including dairy, poultry, and gas, prefer them as a last-mile connection solution.

For instance, an Indian business uses electric three-wheelers to deliver goods to e-commerce and food tech companies like Amazon, Swiggy, and Bigbasket. Additionally, due to their additional advantages, governments in several nations are eager to switch their last-mile delivery fleet to electric. The Delhi Metro, for instance, introduced electric vehicles in 2018 to improve last-mile connectivity for metro stations. The demand for electric three-wheelers is increasing due to the increased use of electric cars, which are more cost-effective than traditional three-wheelers in terms of overall maintenance and running costs.

While it appears evident that the demand for electric 3-wheelers in developed countries is set to grow at CAGR's more than 10% per annum, the growth of electric 3-wheelers in Africa is difficult to predict[68]. While it is acknowledged that a 3-wheeler owner will most likely be able to generate higher income due to higher payloads, electric 2-wheelers still offer greater mobility in areas where road conditions are exceptionally poor.

- The three main reasons for the relative underinvestment in electric 3-wheelers in Africa are:
- They are capital intensive, costing around three to four times the price of an electric motorcycle. Due to weight limitations, space and size requirements, they are less fitting for battery swapping, which both increases their upfront cost to customers and the inconvenience of slow charging.
- The last mile delivery service companies that are the key customer segment for cargo 3-wheel companies in Asia are young in Africa, and most of the last-mile delivery services are already carried out by motorcycles.

[66] https://cleantechnica.com/2024/03/01/tri-launches-its-next-generation-electric-3-wheeler-in-tanzania/
[67] https://www.globalfleet.com/en/manufacturers/global/features/growing-dominance-two-and-three-wheelers?t%5B0%5D=Electric%20%26%20Connected&t%5B1%5D=Smart%20Mobility&curl=1
[68] https://straitsresearch.com/report/three-wheeler-market

- Passenger 3-wheelers do not command as wide a geographic spread as motorcycles, as they are concentrated along the east coast of Africa and in coastal West Africa.

9.4 Market Competitiveness

The most popular ICE motorcycle used for last-mile delivery in South Africa is depicted in the figure below.

Big Boy Commercial 150cc

- Price: R16 799,00
- 70km/h top speed
- Energy: 2,4L/100km

Big Boy Commercial 200cc

- Price: R20 999,00
- 80km/h top speed
- Energy: 2,5L/100km



Figure 20: Big Boy Commercial 150cc

Two examples of entry-level electric motorbikes currently available in South Africa are mentioned below

EWIZZ – Buzz electric scooter

- R65 000 - 5 year/50,000 km battery warranty
- 3 kw drive train with a top speed of 65 km/h
- 72V 3.88 kWh LiNCM battery – 4-hour charge time
- Average range is 100 km @ 50 km/h
- Quickswap battery packs can be swapped in around 20 seconds



Figure 21: Buzz Electric Scooter

SKOOTA – Skoota electric scooter

- R 65 000 – 3 year 40 000km warranty
- 1,5kW motor with 65km/h top speed
- 2kWh Lithium battery – 4-hour charge time
- 65km to 95km range
- Swappable battery pack
- App connected



Figure 22: Scoota Electric Scooter

The current cost price including a battery for an electric two-wheeler is about R65 000 and without a battery about R35 000. The current average cost price for a typical ICE motorcycle used for commercial purposes in SA is R19 500. This shows that battery cell sourcing is the largest-cost item for electric two-wheelers and forms 30% to

40% of the BOM[69]. If battery packs are provided on lease principle through a swapping BaaS (Battery as a System) model, and excluded from the original purchase, price parity can be achieved and TCO will be lower than for ICE two-wheelers.

The TCO for electric two-wheelers is favourable. Even with a higher up-front cost—and assuming no residual value—the electric two-wheeler is 25% cheaper over a five-year life cycle compared with an ICE two-wheeler due to fuel and maintenance savings[70]. A recent pilot by the UK Aid–funded Manufacturing Africa program in Kenya found that more than 90% of the electric two-wheeler drivers felt they performed as well, if not better, than the ICE two-wheeler[71].

9.5 Future Growth

Assessing the market trends in Africa and South Africa, it is clear that there is growth in the South African two-wheeler market as discussed below. This growth is currently underpinned by the growth of the delivery market segment.

This section will discuss the findings following from detailed modelling calculations and results which are provided in Table 17, Table 18 and Table 19 in Annexure D: Opportunity Feasibility Scoping Excel Calculations of this report.

9.5.1 The L-class Vehicle Customer (South African Examples)

A number of companies exist that provide motorcycle rental or lease services, including companies such as listed herewith (See Annexure C: Case Studies for more detail).

- Green Riders: They own their delivery e-bikes, through a two-year rent-to-own scheme. Green Riders have leet partnership deals with a number of aggregators such as Mr D (Takealot), Bolt Food, UberEATS, Pick n Pay, as well as online fashion platform, Bash. In five years' time, they hope to have scaled up the company to have 50,000 e-bikes and e-motorbikes on South African roads, all assembled locally[72].
- Checkers Sixty60 through service provider Pingo, who has 4,000 registered drivers.
- The Takealot Delivery Team is a specialist in last-mile business to consumer deliveries, delivering packages for all Takealot Group companies (Takealot.com, Mr D and Superbalist.com) as well as other independent business services, such as FNB Credit Cards. the Takealot Delivery Team has over 15,000 drivers and over 100 e-bikes already in use. Takealot plans to introduce 500 e-bikes by the end of 2024.
- Valternative Energy (Swap and Go) battery as a service provider.

Whilst these initiatives will contribute towards electric motorcycle and scooter sales, the projected demand in South Africa remains small at circa 6,000 units per annum by 2030.

Last-mile deliveries account for most of the growth related to electric L-class vehicles. Two-, three- and four-wheelers in the last-mile delivery sector are considered investment opportunities. NPV calculations are done to quantify the costs associated with these electric last-mile delivery vehicles in Annexure E: Last Mile Deliveries. The energy storage systems and associated charging infrastructure are also considered in depth to provide a complete view of how a micro-mobility eco-system operates in Annexure E: Last Mile Deliveries.

[69] McKinsey&Co. 2023. The real global EV buzz comes on two wheels. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-real-global-ev-buzz-comes-on-two-wheels#/
[70] McKinsey&Co. 2022. Power To Move. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/power-to-move-accelerating-the-electric-transport-transition-in-sub-saharan-africa
[71] McKinsey&Co. 2022. Power To Move. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/power-to-move-accelerating-the-electric-transport-transition-in-sub-saharan-africa
[72] https://www.engineeringnews.co.za/article/green-riders-to-add-more-e-bikes-e-motorbikes-to-delivery-fleet-2023-06-01

9.5.2 The South African Market Demand

Assessing the market trends in Africa and South Africa, there is extensive growth in the South Africa two-wheeler market, albeit from a low base, as depicted below. This current growth is underpinned by the growth of the delivery market segment.

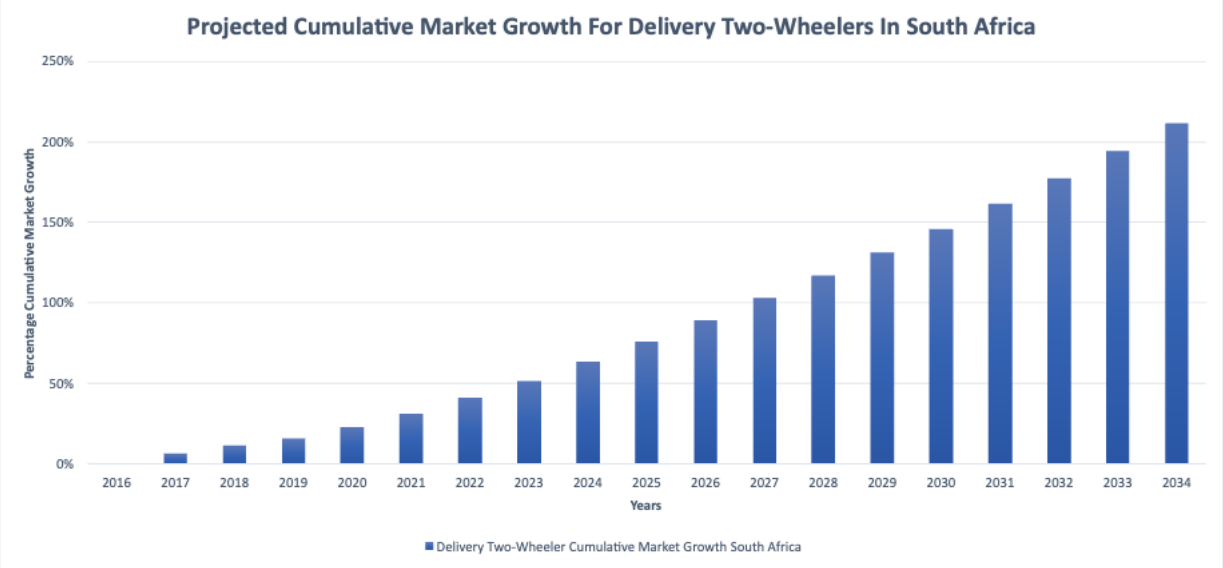


Figure 23: Future Growth Forecast

As highlighted previously, there is a huge growth opportunity for electric two-wheelers in the delivery segment. Subject to the localisation pillar and achieving economies of scale, electric TCO can be on par or lower compared to ICE two-wheelers in South Africa. The key to unlocking this growth opportunity will be charging infrastructure (including swapping, BaaS, etc), robust battery pack, and local assembly/production facilities to be achieved in a phased approach.

In terms of volumes, the new sales of the electric two-wheeler delivery market are expected to grow from a 2023 level of an estimated 210 motorcycles per annum to 2 275 per annum by 2034. This excludes the replacement market. The total estimated fleet by 2034 could be around 15 179 electric two-wheelers.

Assuming a life expectancy of 7 years for a two-wheeler electric delivery motorcycle, the market opportunity by 2034 increase to 2 367 per annum.

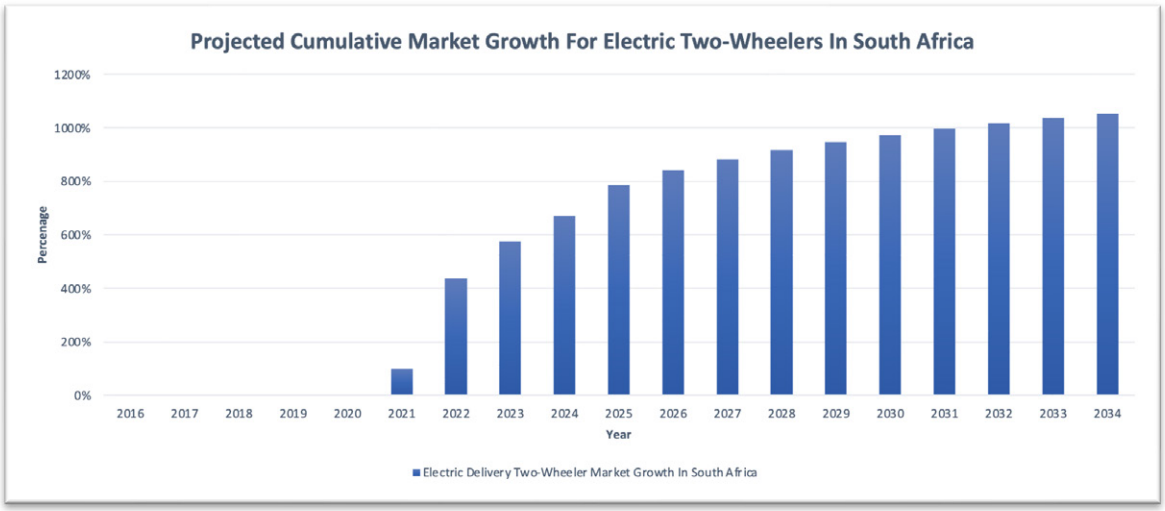


Figure 24: Projected Cumulative Market Growth for Electric Two-Wheelers in SA

From the above graph and modelling, it is the conclusion that the electric two-wheeler delivery market could be in an exponential growth phase over the next 4 to 5 years whereafter growth levels will flatten out. Similarly, the supporting charging infrastructure and battery pack market requirement will follow the same trend.

To achieve economies of scale, a level of standardisation in the market will be required. This implies that the market does not support multiple motorcycle OEMs and standardisation of battery packs and associated infrastructure for utilisation by all-electric delivery two-wheelers. If not, the above market will be fragmented and achieving economies of scale for each OEM may become challenging.

9.5.3 The African Market Demand

According to projected electric market growth trends and AIH's modelling, the two-wheeler electric market could grow to circa 50% of the total two-wheeler market by 2034, in line with the McKinsey report noted earlier. To achieve this projected market penetration, the CAGR for the sales of electric motorcycles should be more than 25% per annum. Based on the projected growth of electric motorcycle sales in Africa at 4% per annum in volume, the sales of electric motorcycles could exceed 1.2 million units in 2040.

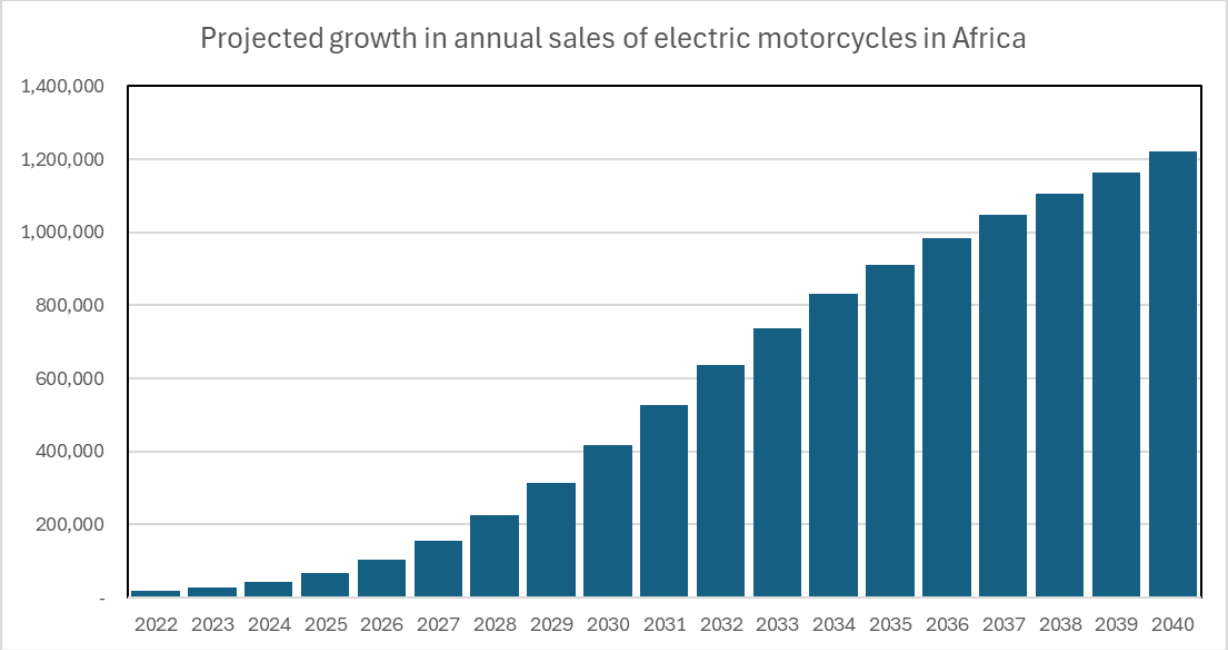


Figure 25: Projected Growth in Annual Electric Motorcycle Sales, Africa

Electric motorcycles lend themselves to ease of assembly and imports of CKD kits comprising various discrete parts such as the frames, brakes (front and rear), electric harness, tyres and rims, front and rear shock absorbers, electric drive and control system, a battery management system, batteries and auxiliary systems.

The African market is further characterised by a scarcity of experts to maintain electric motorcycles and a higher frequency of new parts that require maintenance, such as batteries. The frequency of repairs according to a study published in Elsevier [73] indicates that tire repair leads with 38% followed by the batteries at 32%, traction motors at 25%, and braking systems at 15%. Battery repair faults were mostly related to overcharging (for those without BMS), electrolyte leakage, hot weather, and fast discharge. Some technicians have been trained to repair batteries by testing and replacing affected cells. While battery repair and reuse are being practised, battery recycling is completely absent at the moment. Once the battery is beyond repair or reuse, they are disposed of in landfills.

[73] Feasibility of electric two and three-wheelers in Africa - ScienceDirect

9.6 Battery Market Demand for Delivery Two-Wheelers

The battery market quantification for two-wheelers used for last-mile deliveries was based on the following assumptions, given the standardisation of battery packs:

Table 10: Battery Market Quantification and Assumptions for Delivery Two-Wheelers

Average delivery two-wheeler distance per day	125
Average days used per annum	365
Average kilometres per battery	125
Average charging time for battery (hours)	2
Average two-wheeler operating hours per day	12
Available swaps per operating hours	3
Batteries per two-wheeler per day	2.6
Average cycles per battery	4 000
Battery life at 1 cycle per day (years)	11,0

Based on the above assumptions, the required battery pack pool excluding the battery replacement market will be 6 154 for new two-wheeler battery packs. The cumulative pool based on the estimated fleet size of 15 179 could be around 39 466 battery packs in circulation. Calculations are shown in detail in Table 20 which is provided in Annexure D.

Similar projections are done in Table 20 for the value chain volumes for L-class vehicle components and are provided in Annexure D.

9.7 Challenges to Overcome

While the move towards electric two-wheelers in Africa is imminent, there remain various challenges to be addressed:

Africa needs access to durable motorcycles

A large percentage of electric motorbike start-ups in sub-Saharan Africa rely on ready-built or completely knocked-down (CKD) import units, which are then assembled locally. The rough terrain in which riders travel in sub-Saharan Africa leads to considerable wear and tear on the electric motorbike caused by unpaved roads, long journeys and intensive commercial use. As the suppliers are predominantly based in India, China and South East Asia, the electric motorbikes are not tailored to the African terrain.

Charging infrastructure needs to be reliable and dense

Existing off-grid power supply solutions are often unsuitable for charging the batteries of electric motorbikes. For example, diesel generators are a widely used substitute for grid power, especially in commercial environments across much of SSA, but the high cost and carbon intensity of the electricity produced by diesel generators make them an expensive and less viable option. Alternatives such as Solar Home Systems (SHS), which are used by many households for domestic needs, provide only a fraction of the electricity needed to

charge electric motorbike batteries. Generating PV electricity on site and charging the batteries at decentralised charging stations is a necessary and practicable solution. However, this solution requires considerable investment in a network of battery exchange stations, the lack of which ultimately prevents investment in the electric motorbike sector. The charging infrastructure for e-bikes delivered over the last mile is likely to be supplier-specific and the supporting charging infrastructure could therefore be owned by the suppliers.

Lack of local supply chains

Local production capacities are available, but only for basic components such as subframes, kickers, etc.

Lack of awareness among end consumers

End users lack a perspective for comparing the life cycle costs of electric motorbikes with those of ICE motorbikes. There is also a lack of awareness of the financial and environmental benefits.

Policy and regulatory challenges

In most African countries, there is no specific policy to promote electric mobility and the incentives offered are often not well publicised. Electric motorbikes are subject to import duties and VAT in many of the major African markets. There is a need for aggressive subsidies for end users to reduce vehicle prices. There is also a general lack of standards for the electric motorcycle industry, particularly in terms of safety, performance, charging and construction regulations.

Skills and training

Since electric vehicles are a new vehicle technology, there is a lack of experts who are familiar with their unique design. This is a problem, especially when it comes to maintenance and manufacturing. Electric vehicles are no more difficult to repair than ICE vehicles, but specialised training is required. The structural differences between electric vehicles and conventional vehicles require a different approach to their maintenance National training programmes at all levels of vocational education are needed to train electric vehicle technicians. The establishment of research centres at universities is also essential for the transition to e-mobility.

9.8 Conclusion

The modelling carried out confirmed the market demand and growth opportunities for electric two-wheelers in the delivery market segment. However, this growth needs to be underpinned by the associated charging infrastructure and battery pack leasing model (BaaS).

The greatest growth will take place over the next 4 to 5 years and if entry into this market is not achieved soon, the early growth opportunities will fade and the realisation of economies of scale in the long term will be depend on flattened annual growth and replacement market. However, a market of 2 367 per year by 2034 is considered substantial but if this opportunity can be realised soon, there is a realistic chance of achieving a higher market share and volume of around 6 000 units for electric versus ICE two-wheelers by 2030. In order to achieve economies of scale, the whole African market for electric motorcycle should be considered. Based on the projected growth of electric motorcycle sales in Africa at 30% per annum in volume, the sales of electric motorcycles could exceed 1.1 million units in 2040 as seen in the tables below.

ICE Two-Wheeler Market Assessment:

African Countries	13 Surveyed	51 Extrapolated
Units in 2022	902,583	1,412,928
Units in 2040 (7% CAGR)	1,993,336	2,627,373
Market potential in 2040	USD 5,261 million	USD 6,935 million

Table 2: Electric Two-Wheeler Market Assessment

African Countries	13 Surveyed	51 Extrapolated
Units in 2022	10,705	13,300
Units in 2040 (30% CAGR)	848,729	1,118,687
Market potential in 2040	USD 3,027 million	USD 3,990 million

The above models and analyses show that the light motorbike segment is expected to grow significantly in Africa. This represents a great opportunity for South Africa to develop into a high-tech production centre for the manufacture of complete component packages (CKD kits) for export and motorbike assembly in other African countries.

The establishment of a two- and three-wheeler sector across the continent would open up opportunities for the creation of more production centres, more participating countries and therefore a much larger market. For exports, the key international partnerships for the various pillars need to be utilised as quickly as possible to accelerate market entry.

The value proposition is a large and growing national and continental market for conventional L-Class vehicles that is beginning to convert to electric drive. This industry will be facilitated by the growing regional integration enabled by the advancement of the AfCFTA. It is therefore possible to foresee the development of a significant regional automotive value chain in which South Africa plays a key role, but which also includes many other countries on the continent.

10. INVESTMENT OPPORTUNITIES

The emergence of e-mobility solutions has contributed to the creation of many new companies in Africa and South Africa that support NEV's common goal of scaling its e-mobility solutions in Africa. Players are also addressing different aspects of the value chain and face unique challenges that are being tackled in partnerships with established multinational companies.

Table 11 below shows the typical investment opportunities that could arise from local manufacturing or assembly of L-Class EVs in Africa, charging infrastructure, battery assembly and battery recycling. This report shares these observations with the intention of illustrating the dynamic business and investment opportunities for private sector investors, donors, development finance institutions (DFIs), commercial lenders and policy makers alike. Further exploration of these business opportunities could help unlock new value chains that are uniquely suited to address the industrial development of African mobility, thereby creating new employment opportunities while combating pollution from traditional ICE modalities.

Companies for which detailed literature reviews were conducted include: Eleksa, MellowVans, SolarMD, Roam, Ampersand, Zembo, Honda Manufacturing Nigeria Limited, Stallion Group of Companies, Yamaha Motor and E-Mobility Company. See Appendix C: Case Studies for a detailed discussion of the above companies.

Table 11: Investment Opportunities

Company	Location	Value Chain	Investment Opportunity
ELEKSA	SA	Electric L-class vehicle assembly Component manufacturing	The company's goal is to expand their assembly capabilities and they are looking for partners to invest in automotive production assets and technology that will enable them to assemble electric L-class vehicles at industrial scale. The company is also in the process of developing a business case for the localisation of several components for their electric L-class vehicles.
MELLOWVANS	SA	Electric L-class vehicle assembly Component manufacturing	The company has plans to increase their production to 30 – 40 units a month from 2025. With a large-scale investment, MellowVans will be able to leverage their development and set up a factory to assemble batteries in the Western Cape. They are committed to comply with industry standards, as such they have secured the necessary ISO certification for assembly.
GREEN RIDERS	SA	Electric L-class vehicle assembly	Their goal is to scale up the company in five years to have 50 000 e-bikes and e-motorbikes on South African roads, all assembled locally.
PINGO	SA	Last-mile delivery service provider	Leading last-mile delivery service provider 'Pingo' delivers all Sixty60 orders to Checkers clients. Customers can also track their driver from the store to their door with Checkers' cutting-edge app. Pingo also support qualifying drivers with a range of rented motorbike options.
UBER EATS & MR D FOOD	SA	Last-mile delivery service provider	Uber Eats and Mr D Food is committing to making its e-hailing platform emission-free by transitioning Uber Eats drivers to vehicles such as e-scooters, e-bikes or electric cars by 2040 globally[74]. The investment opportunity lies in investing in their service providers.
TAKE-A-LOT	SA	Last-mile delivery service provider	100 e-bikes were introduced in 2023 and is planning to expand their fleet to 500 e-bikes by the end of 2024. Therefore the investment opportunity lies in investing in their service providers.

[74] Ramalepe, P. News 24. June 2023. Link.

Company	Location	Value Chain	Investment Opportunity
VALTERNATIVE	SA	Last-mile delivery service provider Charging infrastructure	Valternative provides dedicated rider management services to collect its revenue through scooter rentals, battery swopping subscriptions, rider commission fees, and vehicle advertising.
METRO AFRICA EXPRESS (MAX)	Nigeria	Electric L-class vehicle assembly	Expands assembly of two- and three-wheelers in Nigeria with UK funds of $31 million.[75]
ROAM	Kenya	Electric L-class vehicle assembly Component manufacturing	Looking to raise US$17.5 million for OPEX and CAPEX to support its manufacturing operations in Kenya.
SPIRO	Benin, Togo, Rwanda	Electric L-class vehicle assembly Component manufacturing	The African electric scooter, and motorcycle company, received financing of USD 63 million, allowing it to expand its operations to Kenya and Uganda. Spiro has 10 000 vehicles on the roads in three African countries (Benin, Togo, and Rwanda). Plans to add another 15 700 battery-powered vehicles to its fleet.
AMPERSAND	Rwanda, Kenya	Electric L-class vehicle assembly Component manufacturing Battery manufacturing BaaS	Secured USD 19.5 million in funding. A significant USD 7.5 million of the total funding was secured as a debt. This debt was managed by Africa's go green fund (AGG) and will be used to support Ampersand's three main goals, increasing electric motorcycle battery production, expanding the current battery swap station (BST) infrastructure, and accelerating R&D.
E-MOBILITY COMPANY	Nigeria	Electric L-class vehicle assembly Component manufacturing	A Nigerian e-mobility platform, with support from the UK-funded Manufacturing Africa program, has raised $31 million to expand the assembly of electric two- and three-wheelers in Nigeria[76].

[75] E-mobility company in Nigeria to ramp up EV production (esi-africa.com)
[76] https://bing.com/search?q=motorcycle+assembly+facilities+in+Nigeria

Company	Location	Value Chain	Investment Opportunity
HONDA MANUFACTURING NIGERIA LIMITED	Nigeria	ICE Assembly Component Manufacturing	HMN has an assembly plant located in Lagos. They manufacture motorcycles and other power products. The company is known for its high-quality, durable motorcycles, and they have significantly invested in their assembly plant to produce approximately 100 000 bikes annually[77].
STALLION GROUP OF COMPANIES	Nigeria	ICE Assembly Component Manufacturing	They have an assembly plant in Ikotun, Lagos, where they manufacture motorcycles. Stallion produces around 100 000 bikes per year
YAMAHA MOTOR	Nigeria	ICE Assembly Component Manufacturing	Yamaha Motor Co. Ltd. established a motorcycle assembly plant and modern showroom at the Amuwo Odofin Industrial Scheme in Lagos, Nigeria.
SOLAR MD	SA	Battery pack assembly Battery Recycling	Solar MD has demonstrated South Africa's market for quality batteries (currently selling/ producing 550 000 tonnes of batteries per annum). SolarMD is looking for large scale investments to establish a battery recycling plant in the next 5 years which can process up to 550 000 tonnes of batteries per annum.

The above table of business cases and funding requirements is certainly not all inclusive and represents some of the more prominent examples in literature and on-line publications. It does, however, point to the need and opportunity for the development of two- and three-wheeler electric mobility solutions that have far lower barriers to entry than their ICE equivalents. It is indicative of new industry developments on the continent that are geared to development of localised solutions that addresses the unique mobility challenges in Africa and warrant further research to identify and assess new investment, financing opportunities and potential partners for the IDC.

[77] Stallion Group of Companies | Motorcycle

11. GREEN MANUFACTURING AND SPECIAL ECONOMIC ZONES

11.1 South African Economic Sectors and GHG Emissions

South Africa's economic sectors are divided into agriculture, industry and services. In 2022, agriculture contributed about 2.57% to South Africa's GDP, while industry contributed 24.44% and services 62.61%[78]. The contribution of the economic sectors is mainly dominated by the service sector. The contribution to greenhouse gas emissions is shown below:

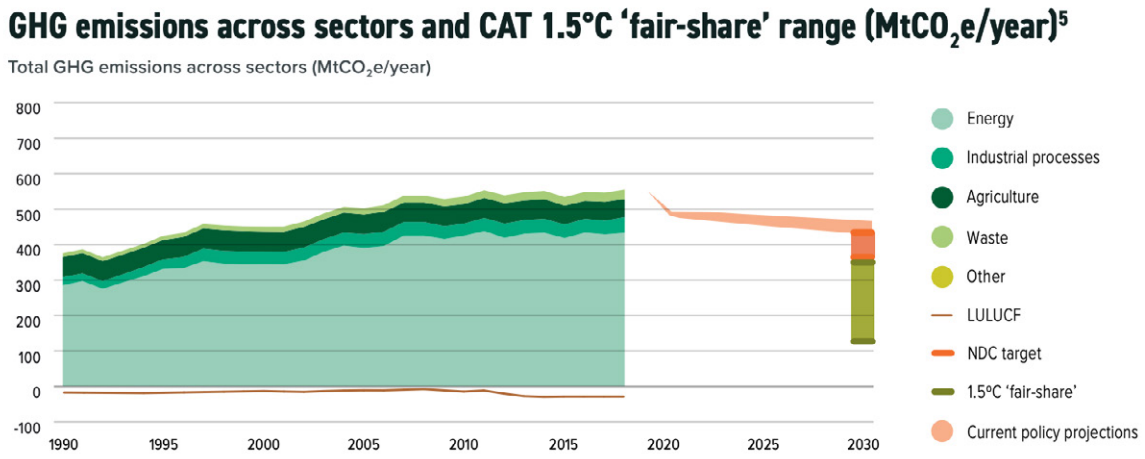


Figure 26: GHG Emissions Across Sectors[79]

Between 1990 and 2018, South Africa's emissions (excluding land use) rose by 48%, reaching 557 $MtCO_2e$. Although there has been some stabilization in recent years, emissions have increased across all categories, except for agriculture, during this period. The lower bound of the updated NDC target range (366-436 $MtCO_2e$, excluding LULUCF) is the closest to meeting a 1.5°C 'fair share' contribution to the Paris Agreement's goals. To align with the 1.5°C 'fair share' target, South Africa must achieve reductions in line with the lower end of its 2030 NDC range. South Africa's per capita emissions, inclusive of land use, is 9.1 (tCO_2e/capita)[2] which is 1.22 times the G20 average which is 7.5 (tCO_2e/capita)[2].

The South African automotive sector contributes to about 4.3% of the country's GDP. South Africa's transport sector is responsible for around 10.8% of national greenhouse gas emissions. To compare this figure, the GHG emissions of countries that are in a transition phase in terms of competitiveness and GHG emissions were collected and compared (see below):

[78] Statistica. South Africa: Distribution of GDP Across Economic Sectors. 2024. https://www.statista.com/statistics/371233/south-africa-gdp-distribution-across-economic-sectors/#:~:text=In%202022%2C%20agriculture%20had%20contributed,the%20total%20value%20added%2C%20respectively.

[79] Climate Transparency. 2021. https://www.climate-transparency.org/wp-content/uploads/2021/10/CT2021SouthAfrica.pdf

Table 12: Total Automotive Sector Emissions Benchmarking

Country	Total Emissions (million metric tonnes)	Total Automotive Sector Emissions	Percentage of Automotive Sector Emissions	Source Total Emissions	Source Transport Emissions
South Africa	404.05[CO_2]	48.48[CO_2]	12%	South Africa: CO2 Country Profile - Our World in Data	South Africa: CO2 Country Profile - Our World in Data
Sweden	48.3[CO_2]	13.96[CO_2]	28.9%	Greenhouse gas emissions from the Swedish economy decrease in 2023 (scb.se)	Sweden: CO2 Country Profile - Our World in Data
Norway	47.56[GHG]	12.29[GHG]	25.8%	Norway: CO2 Country Profile - Our World in Data	Norway: CO2 Country Profile - Our World in Data
Denmark	45.93[GHG]	11.37[GHG]	24.8%	Denmark: CO2 Country Profile - Our World in Data	Denmark: CO2 Country Profile - Our World in Data
Switzerland	42(GHG)	13.8[CO_2]	32.8%	Switzerland: carbon dioxide emissions 1970-2022 | Statista	Switzerland's greenhouse gas inventory (admin.ch)
Austria	55.7[CO_2]	21.93[CO_2]	39.4%	Austria: carbon dioxide emissions 1970-2022 | Statista	Austria: annual greenhouse gas emissions of the transport sector 2021 | Statista
Finland	36.16[CO_2]	8.39[CO_2]	23.2%	Finland: CO2 Country Profile - Our World in Data	Finland: CO2 Country Profile - Our World in Data
United Kingdom	512[CO_2]	174.08[GHG]	34%	Greenhouse gas emissions, UK - Office for National Statistics	Greenhouse gas emissions, UK - Office for National Statistics
New Zealand	78.778[GHG]	29.15[GHG]	38%	Greenhouse gas emissions, UK - Office for National Statistics	New Zealand's greenhouse gas emissions | Stats NZ
France	297.53[CO_2]	83[GHG]	28.23%	France: CO2 Country Profile - Our World in Data	France: CO2 Country Profile - Our World in Data
Morocco	69.1[CO_2]	15.73[CO_2]	19%	Morocco: fossil fuel related CO2 emissions 2023 | Statista	Morocco: CO2 Country Profile - Our World in Data
Egypt	258.95[CO_2]	45.22[CO_2]	17.46%	Egypt: CO2 Country Profile - Our World in Data	Egypt: CO2 Country Profile - Our World in Data
Nigeria	128.76[CO_2]	18.25[CO_2]	14.18%	Nigeria: CO2 Country Profile - Our World in Data	Algeria: CO2 Country Profile - Our World in Data
Algeria	176.35[CO_2]	41[CO_2]	15.5%	Algeria: CO2 Country Profile - Our World in Data	Algeria: CO2 Country Profile - Our World in Data

Countries such as Sweden, Norway, Denmark, Switzerland and even France were used as benchmarks for South Africa, as they are leading the way in reducing their greenhouse gas emissions and the energy transition. Countries such as Morocco, Egypt, Nigeria and Algeria were included to compare South Africa with other automotive centres in Africa and to gain a better understanding of South Africa's position.

11.2 SEZ Introduction

A Special Economic Zone (SEZ) is an economic development tool used to promote national economic growth and exports by using targeted support measures to attract foreign and domestic investments and technology. SEZs are loosely defined as "Designated areas in countries that possess special economic regulations that are different from other areas in the same country. Moreover, these regulations tend to contain measures that are conducive to foreign direct investment.

Conducting business in a SEZ usually means that a company will receive tax incentives and the opportunity to pay lower tariffs"[80]. SEZs are a tool for government intervention into the economy and is the most critical instrument to advance government's strategic objectives of industrialization, regional development and job creation.

SEZs can also help improve the attractiveness of a country as a destination for foreign direct investment. Below is a map of all operational SEZs and IDZs within South Africa.

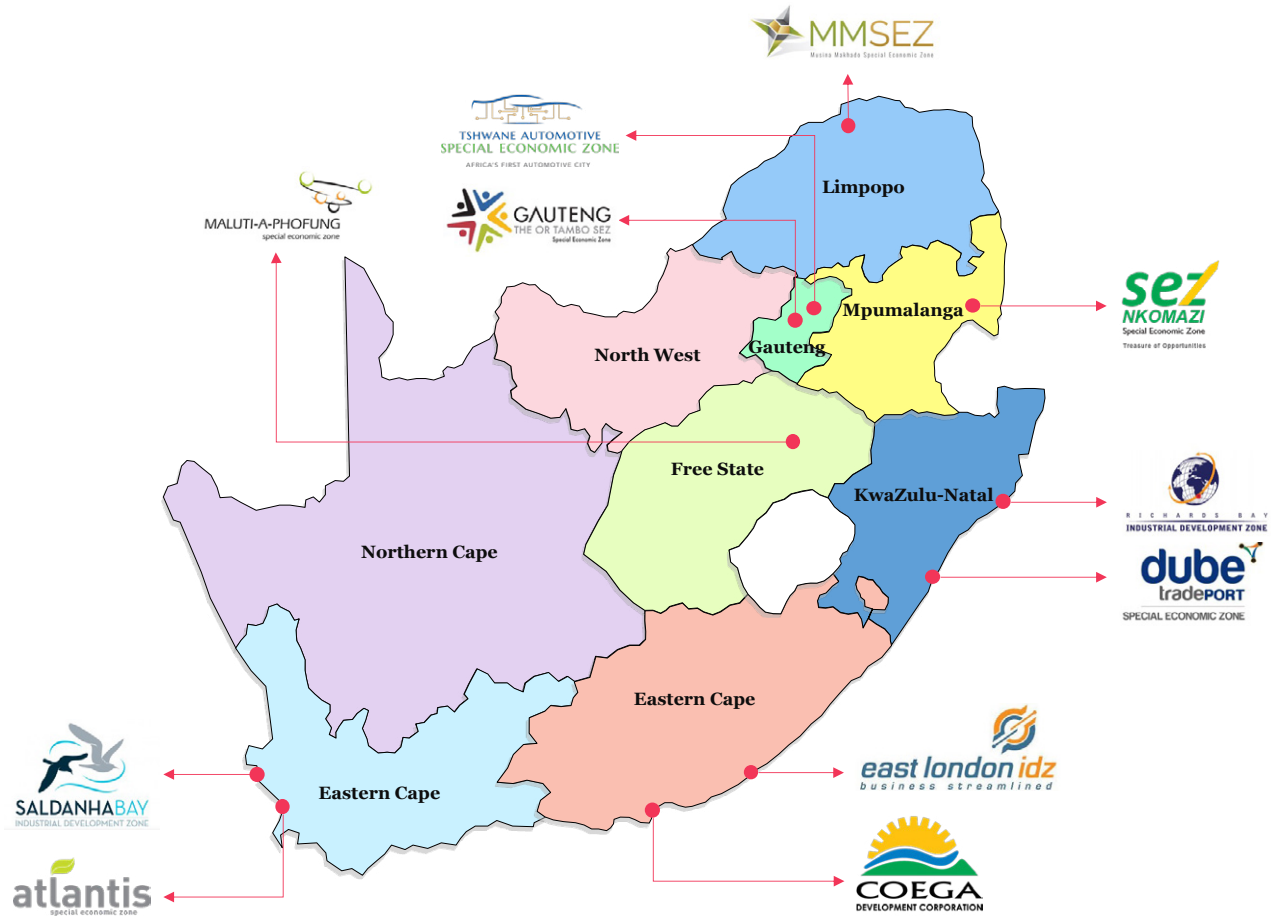


Figure 27: Map of Operational Special Economic Zones in South Africa

[80] SSRN. Special Economic Zone. 2021. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3826775

The benefits of operating within a Special Economic Zone[81]:

- Preferential 15% Corporate Tax
  Businesses (prescribed in section 24(4) of the SEZ Act) that are in a Special Economic Zone may be eligible for tax relief, including the reduced rate of corporate income taxation. In addition to satisfying the requirements of the SEZ Act, further criteria for some of the available tax incentives are stipulated in the Income Tax Act, 1962 (Act No. 58 of 1962).
- Building Allowance
  Businesses and Operators (prescribed in section 1of the SEZ Act) operating within a Special Economic Zone may be eligible for tax relief, including the building allowance, subject to requirements contained in the Income Tax Act.
- Employment Incentive
  Businesses and Operators operating within a Special Economic Zone may be eligible for tax relief, including the employment tax incentive subject to requirements contained in the Employment Tax Incentive Act, 2013 (Act No. 26 of 2013).
- Customs Controlled Area
  Businesses and Operators located within a customs-controlled area of a Special Economic Zone will be eligible for tax relief as per the Value-Added Tax Act, 1991 (Act No. 89 of 1991), the Customs and Excise Act, 1964 (Act No. 91 of 1964), the Customs Duty Act 2014 (Act No. 30 of 2014) and the Customs Control Act, 2014 (Act No.31 of 2014).
- 12I Tax Allowance
  The 12I Tax Incentive is designed to support Greenfield investments (i.e. new industrial projects that utilise only new and unused manufacturing assets), as well as Brownfield investments (i.e. expansions or upgrades of existing industrial projects). The new incentive offers support for both capital investment and training.

An analysis of all eleven operational SEZs within South Africa including their location, size, infrastructure and activities was completed (F: Overview of Special Economic Zones). This analysis aims to provide insight into deciding whether investing into an existing SEZ is feasible and recommended.

11.3 Investment Opportunities

Taking into consideration the four pillars of focus (L-class vehicles, EV charging infrastructure, battery manufacturing, and battery recycling), background information on all eleven operational SEZs in South Africa was analyzed. This information was utilised to make informed recommendations in terms of investing into existing SEZs for localization (refer to Annexure F: Overview of Special Economic Zones).

Investing into an existing SEZ is an attractive investment opportunity as existing SEZs provide various advantages such as established infrastructure and supply chain, component suppliers already transporting to SEZs, and experienced managing bodies. Investing into an existing SEZ also allows for a quick entry into the market as most of the difficulties of building such infrastructure has already been overcome and therefore operations can start as soon as possible.

SEZs also have custom controlled areas which allow components that are imported, goods that are manufactured and produced finished goods are eligible to be exported at a reduced tax rate, which is especially prevalent at SEZs close to ports. In addition, SEZs, with an automotive presence already has component suppliers close by or within the premises of the SEZ which enables access to components at a lower cost and reduced lead time.

[81] The dtic. Special Economic Zones. 2024. https://www.thedtic.gov.za/sectors-and-services-2/industrial-development/special-economic-zones/

The recommendations will be made on the basis of the following opportunities:

- Establishing a new facility to manufacture electric and ICE L-class vehicles.
- Establishing a new facility to convert L-class vehicles from ICE to EV.
- Establishing a new facility to manufacture and/or assemble battery packs.
- Establishing a new facility to recycle batteries.

In terms of **manufacturing** L-class vehicles and **assembling** L-class vehicles from ICE to EV, SEZs close to ports are the most ideal locations namely (Figure 28):

- Atlantis SEZ,
- Coega SEZ,
- East London IDZ, and
- Dube Tradeport SEZ.

In terms of battery **manufacturing/assembly** and **recycling**, the following SEZs are the most ideal locations (Figure below):

- Atlantis SEZ,
- East London IDZ,
- Tshwane Automotive SEZ, and
- Dube Tradeport SEZ.



Figure 28: Summary of SEZ Recommendations

12. CONCLUSION

In conclusion, this report has set out a strategy for building a New Energy Vehicle (NEV) ecosystem in South Africa. The report identifies four pillars that form the foundation of the localisation strategy: L-class electric vehicles, NEV Charging Infrastructure, Battery Manufacturing/Battery Pack Assembly and Battery Recycling.

PHASE 1: ESTABLISH NEV ENVIRONMENT

First and foremost, South Africa needs to establish an environment that will support the successful implementation and development of a sustainable NEV value chain. Phase 1 sets the scene for NEV localisation in South Africa.

This phase includes contextualising the background and analysing the market environment for the four pillars. It is important to understand each of these pillars independently before considering them as a single integrated eco-system.

Another key factor needed to establish a supporting environment for NEVs is to express the need for government intervention; enabling South Africa through appropriate policy principles that will promote NEVs and the green transition.

A shared vision needs to be established for NEVs in Africa and South Africa that will enable engagement and collaboration to ensure knowledge sharing and skills transfer. Establishing a shared vision would entail highlighting the potential for establishing production capacity for all L-type vehicles in South Africa and the region. Another reason for a regional strategy and regional collaboration, for example via the AfCFTA, is to try and develop continental industry standards from an early stage on.

Finally, engagement with local and international partners is vital to understand the NEV environment better and to attract large scale anchor investors. In South Africa, important stakeholders are the key industry federations, NAAMSA and NAACAM. Domestic and international firms are, of course, key. Additional capital could be supplied by institutions such as the IDC, Afreximbank and via the JET-IP process.

PHASE 2: INITIATE LOCALISATION

To initiate localisation, opportunities for investment are identified by considering South Africa's current capabilities and automotive component manufacturing landscape. Gaps within these value chains are highlighted, thereby unveiling potential areas for future development. By targeting electric L-class vehicles as the initial focal point, this strategy aims to lay the groundwork for broader localisation efforts within South Africa's NEV industry.

To initiate the localisation process, phase 2 included mapping of value chains for each of the four pillars to identify investment opportunities that hold potential for competitive manufacturing within South Africa. A scoring matrix was used to rate investment opportunities and L-class vehicle components to be manufactured locally. L-class vehicle components that score the highest are tyres, steel frame, harness and battery pack assembly.

Furthermore, feasibility scoping is done to quantify identified opportunities and to assess the ability to achieve economies of scale. Calculations show that major growth will be over the next 4 to 5 years and if entrance in this market is not achieved soon, the early growth opportunities will subside and achievement of economies of scale in the long term will be dependent on a flattened annual growth and replacement market. A market of 2 367 per annum by 2034 is considered substantial but if this opportunity can be realised soon, the chances of achieving a higher market shares and volumes for electric versus ICE two-wheelers is a realistic additional opportunity.

To reach economies of scale, the whole African electric motorcycle market should be considered. Based on the projected growth of electric motorcycle sales in Africa at 30% per annum in volume, the sales of electric motorcycles could exceed 1.1 million units in 2040 as seen in the table below.

African Countries	13 Surveyed	51 Extrapolated
Units in 2022	10,705	13,300
Units in 2040 (30% CAGR)	848,729	1,118,687
Market potential in 2040	USD 3,027 million	USD 3,990 million

The establishment of a two- and three-wheeler sector across the continent would open up opportunities for the creation of more production centres, more participating countries and thus a much larger market. For exports, the key international partnerships for the various pillars need to be utilised as quickly as possible to accelerate market entry.

The value proposition is a large and growing national and continental market for conventional L-Class vehicles that is beginning to convert to electric drive. This industry will be facilitated by the growing regional integration enabled by the advancement of the AfCFTA. It is therefore possible to foresee the development of a significant regional automotive value chain in which South Africa plays a key role, but which also involves many other countries on the continent.

Two, three and four-wheeled vehicles in the last mile delivery sector are considered as investment opportunities. Net present value calculations are performed to quantify the costs associated with these electric last-mile delivery vehicles. The energy storage systems and associated charging infrastructure are also considered in detail to provide a complete overview of how a micro-mobility ecosystem works.

Case studies of successful L-Class EV ecosystems in Africa are also considered to support localisation. These case studies highlight potential investment opportunities as well as learning opportunities from which valuable information on financially viable business models can be gained.

PHASE 3: NEV ECO-SYSTEM DEVELOPMENT

Developing the electric L-class vehicle ecosystem, forms the basis for expanding towards localising other electric vehicle value chains in South Africa. Phase 3 describes the way forward to achieve a functioning and self-sustaining NEV eco-system in South Africa.

A brief strategy is discussed for integration of the NEV eco-system with green manufacturing and special economic zones in South Africa. Recommendations are made on the basis of the following opportunities:

- Establishing a facility to manufacture electric and ICE L-class vehicles.
- Establishing a facility to convert L-class vehicles from ICE to EV.
- Establishing a facility to manufacture batteries and/or assemble battery packs.
- Establishing a facility to recycle batteries.

This report develops an investment strategy and localisation approach geared towards the development of electric micro-mobility. Considering the four pillars together is crucial for a sustainable NEV eco-system. The aim is that the NEV eco-system supports a circular economy and that it will position South Africa to become the NEV technology hub for Africa.

13. Annexure A: Policy Options

13.1 Motorcycle policy options in the light of current automotive policy

This study has identified electric two- and three-wheelers as a major investment opportunity. The motorcycle market in Africa (and South Africa) is growing rapidly. In parts of West and East Africa, the market is already substantial. In South Africa, online sales and associated goods delivery are driving the rapid expansion in demand for smaller motorcycles.

Currently, there is very little production of motorcycles (both conventional ICE and electric) in South Africa (or the rest of the continent) apart from small scale assembly. But motorcycles present an important production opportunity across the continent.

Consideration, therefore, needs to be given to how this major new industry could be established in South Africa (and Africa more broadly). To move beyond simple assembly, high volume production is required to make it possible to attain economies of scale in component production. In turn this requires sufficient market size, which can be obtained by regional (or continental) trade integration. A second requirement is some form of protection from imports from outside the region/continent. This would require a level of tariff protection against imports into Africa.

In South Africa, most automotive production falls under the ambit of the Automotive Production and Development Programme (APDP). Motorcycles are currently excluded from the APDP, which, like its forerunner, the Motor Industry Development Programme (MIDP), is focused on the light passenger vehicle and light commercial vehicle segments. The original rationale is that light vehicles comprised the bulk of the South African industry. Medium and heavy commercial vehicles (MCV/HCV) partly qualify in that they can apply for assistance in terms of the Automotive Incentive Scheme (AIS) and MCV/HCV component exports can qualify for APDP support.

13.2 Issues for policy consideration

Motorcycles (and motorcycle parts) are currently subject to zero tariffs. In the South African Automotive Masterplan (SAAM) process, it was proposed that a tariff be imposed on motorcycles with the rationale being that this would create an assembly opportunity for other SADC states which could then access the SA market on a duty-free basis.

Consideration could be given to the partial incorporation of motorcycles into the APDP. It is noted that full incorporation would be a major policy adjustment. Steps that could be taken to partially incorporate the sector are as follows:

1. Impose tariffs on motorcycle imports (as was proposed in the SAAM process). These tariffs would be on imports from outside of Africa.
2. Provide AIS support for qualifying investments in motorcycle assembly. A key requirement of qualification would be scale of operation, as small-scale assembly adds little value and negates the possibility for component supply to assemblers.
3. Allow AIS support for qualifying investments in electric motorcycle batteries. As with assembly, the scale of investment would be important because of the economies of scale in this sector.
4. Allow specified motorcycle component exports to qualify for APDP benefits. These would be components that are being supplied into established supply chains.

It is important to note that the above measures would place the motorcycle segment on a similar basis to the MCV/HCV sector.

Apart from the proposal for AIS support in relation to batteries for electric motorcycles, these proposals do not make a distinction between ICE and electric motorcycles. There are many common parts, and the two sub-sectors could co-develop.

It would also be a simple matter for the AIS to be used to specifically support electric two-wheeler assembly and associated components.

Other policies, both locally and across the continent, would be required to promote the transition to electric two wheelers.

13.3 Some complications

Including motorcycles in the APDP is a major exercise and would require a separate policy process. For example, it would require tariffs to be imposed and detailed policy work in terms of defining production processes in relation to APDP policy parameters, specifying volumes etc. It also has implications for the 'balance' of the policy, for example, the duty pool. It would draw on the fiscal resources, which are currently devoted to the AIS, and are in short supply.

However, it is already the case that the export of MCV/HCV components into established OE supply chains 'qualifies' in terms of the APDP.

13.4 Other measures

Other conventional measures could also be used to support the development of industry. These would include tariffs and investment support in the form of investment subsidies or allowances.

14. Annexure B: Opportunity Scoring Matrix

Table 13: Opportunity Score Reasoning 1

Opportunity Scroring Matrix											Score Legend: 1-LOW 5-MEDIUM 10-HIGH
	Criteria										
Opportunity / Component	Projected Demand (<5 yrs)	Economic Potential	Job Creation Potential	Current Capability	International Partners	Support Industries	OEM Support	Local Partners	Total	Average	
L-class Vehicle Manufacturing and Assembly	9	7	8	10	7	10	6	8	65	8,13	
	Projected demand in Africa is high, with a CAGR of >25%	Scored in proportion to other opportunities	Assembly/ manufacturing facilities provide direct jobs in the automotive industry	Simple/uncomplex design. SA has the neccissary skills/ knowledge	Many international companies in this space (India & China)	SA has an established passenger vehilce supply chain, and can easily expand support towards L-class	OEMs in SA can potentially support L-class manufacturing	Companies in Africa already assembling/ manufactruing L-class			
Charging Infrastructure Provision	9	6	5	9	8	9	6	8	60	7,50	
	High demand as number of EVs increase	Scored in proportion to other opportunities	Most charging stations/ battery swap stations are self-service	Simple/uncomplex design. SA has the neccissary skills/ knowledge	Many international companies in this space (India & China)	SA has a growing passenger vehilce charging network, and is still expanding charging infrastructure	OEMs in SA are investing in NEVs and supporting charging infrastructure	Companies in Africa with charging infrastructure business models			
Battery Cell Manufacturing	7	8	7	1	5	3	5	3	39	4,88	
	Global demand is currently being satisfied by Chinese companies, but demand is still rising	Potentially a USD6-7bn supply chain investment and USD100m/ GW investment for a cell manufacturing factory	Cell manufacturing plant is labour intensive. SA might not currently have the neccisary skills/ knowledge in its workforce	Highly complex skills, knowledge and technology needed to plan, build and operate a Gigafatory. High costs associated with cell manufacturing is also a limiting factor for SA	Growing number of international companies in this space (mainly Chinese companies)	SA does not currently have an established battery cell supply chain. SA does not have battery cell manufacturing capabilities	OEMs in SA are investing in NEV manufacturing which can support the battery cell deamnd	Limited local companies in SA and Africa associated with battery cell manufaturing, but stakeholder engagement showed that this might change soon			

Table 14: Opportunity Score Reasoning 2

Opportunity Scroring Matrix											Score Legend: 1-LOW 5-MEDIUM 10-HIGH
	Criteria										
Opportunity / Component	**Projected Demand (<5 yrs)**	**Economic Potential**	**Job Creation Potential**	**Current Capability**	**International Partners**	**Support Industries**	**OEM Support**	**Local Partners**	**Total**	**Average**	
Battery Pack Assembly	8	6	8	9	8	6	5	9	**59**	**7,38**	
	High demand because of global transition towards renewable energy, which increases the need for other battery enery storage systems	This can be done as a sub-process in many industries	Battery pack assembly is labour intensive and SA have the neccisary skills	SA already have a number of companies in this industry, and has capabilities with Battery Management Systems	Many international companies in this space	SA does not currently have an established battery cell supply chain. SA does have battery pack assembly capabilities	OEMs in SA are investing in NEV manufacturing which includes battery pack assembly	Companies in SA already assembling battery packs			
Mining and Benefication of Battery Minerals	8	8	8	7	8	6	5	7	**57**	**7,13**	
	High demand because of global transition towards renewable energy, which increases the need for other battery enery storage systems	These projects require investments ranging from USD50-200m per project	Highly labour intensive and SA has the neccisary skills and knowledge in the mining industry	SA/African companies can beneficiate to an industrial mineral level (99.9%, metal grade and sulphate)	Many international companies in this space	SA does not currently have an established battery cell supply chain. SA does have battery mineral processing capabilities	OEMs in SA are investing in NEV manufacturing which can support the battery cell deamnd	Companies in Africa already mining and beneficiation of battery minerals			
Battery Recycling Facility	6	5	7	5	5	4	5	5	**42**	**5,25**	
	Growing demand as global stockpile of end-of life batteries increase. Demand in SA still limted as most batteries have not reached their end-of-life yet	Scored in proportion to other opportunities	Highly labour intensive. SA might not currently have the neccisary skills/ knowledge in its workforce	SA/Africa does not currently have a battery recycling facility	Growing number of international companies in this space (mainly Chinese companies)	SA does not currently have an established battery cell supply chain. SA does not have battery recycling facilities and the related infrastructure	OEMs in SA are investing in NEV manufacturing which can support the battery cell deamnd	Limited local companies in SA and Africa associated with battery recycling			

Table 15: Opportunity Scoring Reasoning 3

Opportunity Scroring Matrix											Score Legend: 1-LOW 5-MEDIUM 10-HIGH
	Criteria										
Opportunity / Component	**Projected Demand (<5 yrs)**	**Economic Potential**	**Job Creation Potential**	**Current Capability**	**International Partners**	**Support Industries**	**OEM Support**	**Local Partners**	**Total**	**Average**	
L-class Vehicle Components											
Steel Frame	8	7	9	10	9	10	9	9	**71**	**8,88**	
	An estimated 2.6 million motorcycle sales projected in Africa by 2040. Demand for both ICE and EV motorbikes	Scored in proportion to other components	Manufacturing facilities provide direct jobs in the automotive industry. Labour intensive process	Simple/uncomplex component. SA has the neccissary skills/ knowledge. SA has the correct steel grade locally available. Many companies in SA/Africa in this space	Many international companies in this space (India & China)	SA has an established passenger vehilce supply chain, and can easily expand support towards L-class components	There is a presence of L-class OEMs in SA and could potentially support L-class	Companies in Africa already assembling L-class and is looking to increase sourcing of locally manufactured components			
Tyres	9	8	9	9	9	10	9	9	**72**	**9,00**	
	An estimated 2.6 million motorcycle sales projected in Africa by 2040. Large tyre aftermarket (sales and replacements) in Africa	Scored in proportion to other components. Substantial investment needed to set-up	Manufacturing facilities provide direct jobs in the automotive industry. Labour intensive process	Simple/uncomplex component. Africa has the neccissary skills/ knowledge. Africa has the necessary raw materials	Many international companies in this space	SA has an established passenger vehilce supply chain, and can easily expand support towards L-class components	There is a presence of L-class OEMs in SA and could potentially support L-class	Companies in Africa already assembling L-class and is looking to increase sourcing of locally manufactured components			
Brake System	8	6	7	6	6	10	8	8	**59**	**7,38**	
	An estimated 2.6 million motorcycle sales projected in Africa by 2040. Aftermarket adds to demand	Scored in proportion to other components. Relatively inexpensive to set-up	Manufacturing facilities provide direct jobs in the automotive industry	Simple/uncomplex component. SA has the neccissary skills/ knowledge. Some components in the brake system is currently imported	Many international companies in this space	SA has an established passenger vehilce supply chain, and can easily expand support towards L-class components	OEMs in SA can potentially support L-class	Companies in Africa already assembling L-class and is looking to increase sourcing of locally manufactured components			
Shock Absorbers	8	6	7	7	6	10	8	8	**60**	**7,50**	
	An estimated 2.6 million motorcycle sales projected in Africa by 2040. Aftermarket adds to demand	Scored in proportion to other components. Relatively inexpensive to set-up	Manufacturing facilities provide direct jobs in the automotive industry	Simple/uncomplex component. SA has the neccissary skills/ knowledge	Many international companies in this space	SA has an established passenger vehilce supply chain, and can easily expand support towards L-class components	OEMs in SA can potentially support L-class	Companies in Africa already assembling L-class and is looking to increase sourcing of locally manufactured components			

Table 16: Opportunity Scoring Reasoning 4

Opportunity Scroring Matrix											Score Legend: 1-LOW 5-MEDIUM 10-HIGH
	Criteria										
Opportunity / Component	**Projected Demand (<5 yrs)**	**Economic Potential**	**Job Creation Potential**	**Current Capability**	**International Partners**	**Support Industries**	**OEM Support**	**Local Partners**	**Total**	**Average**	
Harness	6	6	9	8	8	10	9	9	**65**	**8,13**	
	An estimated 2.6 million motorcycle sales projected in Africa by 2040. Not a large aftermarket demand	Scored in proportion to other components. Relatively inexpensive to set-up	Manufacturing facilities provide direct jobs in the automotive industry. Labour intensive process	Simple/uncomplex component. SA has the neccissary skills/ knowledge	Many international companies in this space	SA has an established passenger vehilce supply chain, and can easily expand support towards L-class components	There is a presence of L-class OEMs in SA and could potentially support L-class	Companies in Africa already assembling L-class and is looking to increase sourcing of locally manufactured components			
Battery Cell	6	9	7	1	5	3	5	3	**39**	**4,88**	
	Global demand is currently being satisfied by Chinese companies, but demand is still rising	Potentially a USD6-7bn supply chain investment and USD100m/ GW investment for a cell manufacturing factory	Cell manufacturing plant is labour intensive. SA might not currently have the neccisary skills/ knowledge in its workforce. A lot of the processes in a gigafactory is automated	Highly complex skills, knowledge and technology needed to plan, build and operate a Gigafatory. High costs associated with cell manufacturing is also a limiting factor for SA	Growing number of international companies in this space (mainly Chinese companies)	SA does not currently have an established battery cell supply chain. SA does not have battery cell manufacturing capabilities	OEMs in SA are investing in NEV manufacturing which can support the battery cell deamnd	Limited local companies in SA and Africa associated with battery cell manufaturing, but stakeholder engagement showed that this might change soon			
Battery Pack	8	6	8	9	8	6	5	9	**59**	**7,38**	
	An estimated 1.1 million electric motorcycle sales projected in Africa by 2040. High demand because of global transition towards renewable energy, which increases the need for other battery enery storage systems	This can be done as a sub-process in many industries. Relatively inexpensive to assemble/set-up	Battery pack assembly is labour intensive and SA has the neccisary skills	SA already have a number of companies in this industry, and has capabilities with Battery Management Systems	Many international companies in this space	SA does not currently have an established battery cell supply chain. SA does have battery pack assembly capabilities	OEMs in SA are investing in NEV manufacturing which includes battery pack assembly	Companies in SA already assembling battery packs			

15. Annexure C: Case Studies

Green Riders

- Green Riders owns the e-bikes it delivers as part of a two-year rent-to-own scheme.
- The cost of an e-bike is around R40 000.
- The e-bike with two batteries can be charged either at home, at a Green Riders charging station or at designated partner charging stations and drop-off points.
- The bikes are assembled in Cape Town, largely from imported parts.
- The range is currently around 60 km per battery, which corresponds to 120 km with the two-battery system currently in use.
- Charging a single battery (1 kW) takes between three and four hours and costs around R2 per charge.
- Their goal is to grow the business to 50 000 e-bikes and e-motorbikes on South African roads within five years, all assembled locally.

Checkers Sixty60 via service provider Pingo

- Offers a 60-minute delivery service to more than 100 locations across six provinces in South Africa. In addition, customers can send goods and drinks to friends and family members who live in Sixty60's delivery zones.
- The leading delivery service 'Pingo' delivers all Sixty60 orders to Checkers customers. Checkers' innovative app allows customers to track their driver's journey from shop to door.
- Pingo supports qualified riders with a range of rental bikes:
  - Rental costs are automatically covered by the required insurance and deducted from the rider's weekly wage.
  - During the term of the rental agreement, Pingo pays an amount of R550 per month, and the rider must regularly maintain their motorbike. All other expenses (over R550) are the responsibility of the rider.

Take-A-Lot and Uber Eats

- Currently has more than 15 000 drivers and plans to introduce 500 e-bikes by the end of 2024.
- Takealot has 90 branches and over 15 000 drivers.
- Drivers earn an average salary of R10 750 per month.
- 100 e-bikes introduced in 2023 and is planning to expand their fleet to 500 e-bikes by the end of 2024.
- E-bikes have a 30km per hour speed limit restriction, so there's no need for a license to drive one.
- Mr D Food - Drivers earn between R5 000 to R12 000 per month.
- Experienced growth of 210% in the number of orders.
- Also processed over R500 million worth of orders the past 12 months and has over 270 000 active users.
- Uber Eats and Mr D Food collectively account for 90% of South Africa's fast food delivery market.
- Uber is committing to making its e-hailing platform emission-free by transitioning Uber Eats drivers to vehicles such as e-scooters, e-bikes or electric cars by 2040 globally[82].

[82] Ramalepe, P. News 24. June 2023. Link.

- Cape Town would be the first city to have a fully electric package delivery with 100 bikes available at launch[83].

Valternative Energy (Swap and Go)

- Valternative provides dedicated rider management services to collect its revenue through scooter rentals, battery swopping subscriptions, rider commission fees, and vehicle advertising.
- Valternative Energy will use types of electric bikes in the fleet from:
  - the V1 with 1.5kW of power, up to 90km of range, and a top speed of 55km/h; and
  - the V1 Max with 4.0kW of power, up to 110km of range, and a top speed of 95km/h.
- Using the Battery as a Service (BaaS) model, the battery swop-and-go stations will be strategically placed at shopping centres and larger office parks to ensure riders can swop out their depleted batteries for fully replenished ones.
- These swop-and-go stations will be monitored by intelligent software which will manage the charging and security.
- The software is hosted on Amazon's cloud server providing fast access to monitor charging progress and security, as well as manage the riders and the assets to their best performance and safety.
- This is like a very successful implementation by Gogoro.

Eleksa

Eleksa, a company established in 2013 to deal exclusively with the assembly of light electric vehicles. The company has successfully established a marketing and distribution footprint with sales volumes that makes it economic to assemble light electric vehicles in South Africa.

Since their inception, Eleksa's business model has been to specialise in the assembly and accessorising of their electric L-class vehicles. The company's goal is to expand their assembly capabilities and they are looking for partners to invest in automotive production assets and technology that will enable them to assemble electric L-class vehicles at industrial scale. The company is also in the process of developing a business case for the localisation of several components for their electric L-class vehicles.

Eleksa has proven that there is a market for L-class electric vehicles in South Africa. They currently import complete built units (CBU) from China, selling around 100 units per month and is looking to expand their sales to 150 units per month.

MellowVans

MellowVans continues to display SA's technical capability to design high-quality L-class vehicle and shows SA's capability to export and supply European market. The company has established networks with existing retailers and logistics companies such as DPD, SKYNet, DHL, Takealot and SPAR. MellowVans have developed an electric vehicle (L-class) for last-mile transport in urban areas. The vehicles are available for sale, alternatively they can be leased with a comprehensive maintenance contract. Three wheelers are ideal for medium sized goods that are bigger in size and volume. MelowVans is targeting a production of 30-40 vehicles per month soon.

The company imports lithium-ion battery cells from Asia, while assembling the battery pack in the Western Cape. MellowVans have a delivery capacity which is 10 times more than conventional motorbikes, thus meaning they operate for longer and further. This makes the vehicles ideal for e-commerce last mile distribution.

[83] Akabor, N. City Press. November 2024. Link.

Additionally, the vehicles are emission-free, contributing to the reduction of carbon emissions and promoting sustainable mobility solutions.

The company has plans to increase their production to 30 – 40 units a month from 2025. With an investment from the IDC, MellowVan will be able to leverage their development and set up a factory to assemble batteries in the Western Cape. They are committed to comply with industry standards, as such they have secured the necessary ISO certification for assembly.

SolarMD

Solar MD is battery systems developer and manufacturer, based in South Africa. The company was established in 2014, with the objective of providing affordable clean energy systems. To date, Solar MD has developed residential and commercial battery storage solutions, and its products are distributed all over the African continent.

Solar MD has demonstrated South Africa's market for quality batteries (currently selling/producing 550 000 tonnes of batteries per annum). SolarMD is looking for large scale investments to establish a battery recycling plant in the next 5 years which can process up to 550 000 tonnes of batteries per annum.

Roam Case Study

Roam, formerly known as Opibus, is a Swedish-Kenyan company founded in 2017 by Filip Lövström and Mikael Gånge, with a mission to implement electric mobility in emerging markets. Initially it began as a research project at one of Sweden's top technical universities before transforming into an electric mobility company. Roam settled in Kenya given the country's steady rise as one of sub-Saharan Africa's fastest-growing nations, especially in relation to electric mobility adoption. Kenya's growing used vehicle import market also provides a basis for electric conversions, which was the focus in Roam's inception years.

Recent analysis by McKinsey & Company suggests that as much as 35% of the vehicle fleet in sub-Saharan Africa's five largest vehicle markets (excluding South Africa) will be electric by 2040. A study commissioned by FMO (the Dutch Development Bank) in 2022 found 50 EV-related start-ups in Kenya alone. Electric motorcycles are expected to lead this transition since they are most representative of the transport scenario.

In 2019, Roam's market research revealed a lack of reliable, high-quality and environmentally friendly transportation means for African commuters. It established that an affordable transportation alternative to the fossil fuel-powered vehicles can be provided by achieving end-user savings from lower operational and maintenance cost of the motorcycles. With these inputs and extensive product market analysis, Roam decided to design and manufacture its own electric motorcycles locally in Kenya.

Roam is now one of the leading electric motorcycle manufacturers in Kenya with sales exceeding 200 units per month. Roam's business model is selling electric motorcycles to asset financiers, energy companies and other enterprises in logistics and transportation. The company sells electric motorcycles at almost price parity with the ICE equivalent. By selling electric motorcycles on an upfront cash basis to businesses, Roam passes on the asset financing requirement and where possible, operating the charging infrastructure to its network partners. Most recently, Roam partnered with MKOPA, an African asset financing platform, signing a supply agreement that will see mass deployment of electric motorcycles financed through the MKOPA platform using a pay-as-you-go model.

Roam is also partnering with mini-grid companies that can finance and provide charging infrastructure to acquire rural customers. This is an attractive proposition for mini-grid developers as electric mobility could potentially increase demand at their sites, acting as anchor clients. Consequently, Roam has partnered with Powerhive, a mini-grid developer with existing sites in Kenya.

According to Roam, manufacturing and local assembly is key to reducing the final price of electric motorcycles while

also allowing for product customisation to meet local market needs. In addition, Roam's ambition is to build all the hardware and software infrastructure which other key players in the industry can utilise. This is comparable with Gogoro's "hardware as a service" model. In this model, they sell underlying hardware such as bike components and kit parts to original equipment manufacturers (OEMs) which greatly increases interoperability within the battery-swapping network.

Roam currently has the capacity to design 100% and manufacture 35% of its electric motorcycle in-house. It has an ambitious goal to manufacture and assemble as much as 70% of the motorcycle locally over the next 3-5 years. Its next-generation electric motorcycles will even include proprietary frames, a first of its kind in Africa.

Roam has prioritised components where local manufacturing capacity already exists, e.g. injection moulding, welding, metal bending and sub-assemblies. Roam is collaborating with 10 local suppliers that currently manufacture ICE motorcycle parts to help them transition to electric motorcycle manufacturing. Since some components such as battery cells and base components (resistors and converters) require high production standards and capital expenditure to set up locally, these will still have to be procured internationally.

Besides scaling locally, Roam has plans to expand beyond Kenya to other African markets through strategic partnerships. One such partnership is to supply Uber with 3,000 electric bikes for its delivery services. Through this partnership, Roam will strategically position itself to scale across Uber's geographical reach, including Ghana, Nigeria, Ivory Coast, Tanzania, Uganda and South Africa.

Over the years, Roam has evolved to provide tailored solutions to meet market demand through business segments that today include:

- Roam Air, a tailored electric motorcycle for Africa.
- Roam Transit, a segment focused on manufacturing public transport solutions such as electric buses.
- Roam Energy & Charging distributes off-the-shelf energy products.
- Roam Canopy provides tailored software applications to fleet owners, business operators, financiers and others.

Ampersand Case Study

Ampersand is Africa's first electric transport energy company with the longest track record of serving a commercial e-motorcycle fleet and battery swapping network at scale. This company is developing a network of battery-swapping stations in Rwanda and Kenya to enable two-wheeler drivers to exchange depleted batteries for fully charged batteries on the go[84].

Since Ampersand was founded in 2016, it has grown to be best in class for technology and performance, with more than 300 employees and a presence in Rwanda and Kenya. Through extensive testing and R&D, Ampersand has grown its fleet to a current 1 350 and is expected to surpass 10 000 by the end of 2024[85].

By powering commercial transport through its reliable electrical energy supply, Ampersand is paving the way for affordable, lower-carbon public transport, creating green jobs. Their business model and technology are designed to fit seamlessly with drivers' operations. Drivers access smart batteries on demand from the network of Ampersand swap stations.

Ampersand enables to drivers enjoy the savings of e-mobility without the upfront cost, and risk of buying a lithium battery pack or increasing downtime while waiting for batteries to recharge.

[84] McKinsey & Co. 2022. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/power-to-move-accelerating-the-electric-transport-transition-in-sub-saharan-africa
[85] Ampersand. 2024. https://www.ampersand.solar/technology

Renting a charged battery from Ampersand saves drivers around 35% compared to fuel and oil changes. Each battery delivers around 350 000 km of range over its lifetime, and 50-110km per swap depending on the type of usage, the roads travelled, and weight carried. This means drivers need to swap out less frequently than drivers in East Africa typically refuel with petrol. It's all made possible by Ampersand's unique Amper-Ops connected network of smart batteries, swap stations, and a vehicle drivetrain tailored to our customers' needs and African roads.

Zembo Case Study

Zembo, founded by Etienne Saint-Sernin and Daniel Dreher in 2018, is a startup selling electric boda bodas (motorcycle taxis) across Uganda. Drivers swap discharged batteries for fully charged batteries at one of 27 battery-swap stations operated by Zembo and pay for the energy consumed. Zembo has since expanded to 30 employees, spread across Lyon, France and Kampala, Uganda. The team has employed an additional 45 employees across its battery-swap stations who work as "battery swappers".

Uganda has an estimated 700 000 motorcycle taxis and a green grid: 90% of Uganda's national electricity generation is from hydropower. Uganda also does not subsidise the fossil fuel industry, which means high end-user prices allow the electric mobility market to be competitive. Leveraging this opportunity, Zembo aims to build, own and operate the nation's largest swapping network while selling electric motorcycles.

Zembo's business model:

Zembo sells electric motorcycles on a pay-as-you-go basis to Boda Boda drivers and provides battery-as-a-service (BaaS) through a network of battery-swap stations. Zembo's target customers are Boda Boda drivers, as the battery-swap model ensures higher savings for those who use the motorcycle more intensely – as well as higher revenues for Zembo's swap stations. According to an environmental and social impact assessment by Zembo, regular Zembo drivers earn up to an additional US$7 per week, 50% more compared to ICE motorcycle taxis.

Zembo's battery-swapping service is the infrastructure needed to make electric mobility a viable transport alternative in Uganda. At a battery-swap station, a driver stops and removes the battery so that the swapper can scan the QR code on the outside. The swapper then selects a charged battery from the station and scans it before inserting it into the driver's motorcycle. Once the batteries have been identified, the difference in energy is calculated and the rider is charged for the energy. The swap is completed in just two minutes, making it as convenient as filling up fuel at a petrol station.

Zembo's core strategy is to build and own a nationwide network of charging stations that offer charging as a service to Zembo drivers and drivers of other electric mobility companies. The 27 charging stations include 20 grid-connected stations, three solar hybrid stations and four off-grid stations. Zembo is rapidly expanding the more cost-effective grid-connected stations and implementing hybrid stations in areas with particularly high demand. Solar-powered, off-grid charging stations are being installed in areas without a grid connection. Zembo aims to build a nationwide network of charging stations, including off-grid areas, and is starting to connect larger urban areas with on-street stations.

A PREO scenario analysis, in which 500 electric motorbikes are replaced at the existing 27 stations, showed that off-grid stations and hybrid stations are more profitable on an operational level than grid-connected stations. This is due to the high unit costs for grid electricity (US$0.21/kwh) and the fixed labour costs for the swappers, which account for 55% of the direct costs of operating a swap station. Zembo is trialling two innovations to improve the profitability of the swap stations: Franchising of swap stations and the use of battery swap cabinets.

Nigerian Supplier Companies

Nigeria has witnessed significant growth in motorcycle assembly facilities over the years, such as:

Honda Manufacturing Nigeria Limited:

- Honda Manufacturing Nigeria Limited (HMN) is a subsidiary of Honda Motor Co. Japan and was incorporated in 1979. They are Nigeria's No. 1 Power Products company[86].
- HMN has an assembly plant located at Km 6 Idiroko Road, Agege, Lagos State. They manufacture motorcycles and other power products.
- The company is known for its high-quality, durable motorcycles, and they have significantly invested in their assembly plant to produce approximately 100 000 bikes annually[87].

Stallion Group of Companies:

- Stallion Group is the exclusive distributor for Kasea and Qingqi motorcycles in Nigeria.
- They have an assembly plant in Ikotun, Lagos, where they manufacture motorcycles. Stallion produces around 100 000 bikes per year.
- Kasea motorcycles are known for their durability and ruggedness, making them popular with farmers and Okada operators[88].

Yamaha Motor:

- Yamaha Motor Co. Ltd. established a motorcycle assembly plant and modern showroom at the Amuwo Odofin Industrial Scheme in Lagos, Nigeria.
- They assemble and sell models ranging from the entry-level Crux to the YZF-R3[89].

E-mobility Company:

- A Nigerian e-mobility platform, with support from the UK-funded Manufacturing Africa program, has raised $31 million to expand the assembly of electric two- and three-wheelers in Nigeria[90].

These facilities play a crucial role in meeting the transport needs of Nigerians, whether through conventional motorcycles or the burgeoning electric vehicle market.

86 Honda Manufacturing Nigeria Limited
87 Stallion Group of Companies | Motorcycle
88 Yamaha Motor opens motorcycle assembly plant in Lagos, Nigeria
89 E-mobility company in Nigeria to ramp up EV production
90 https://bing.com/search?q=motorcycle+assembly+facilities+in+Nigeria

16. Annexure D: Opportunity Feasibility Scoping Excel Calculations

Table 17: ICE Motorcycles Projected Market Demand for Africa

ICE Motorcycles Projected Market Demand For Africa										
	Trade Map - List of supplying markets for a product imported by Egypt				Select CAGR	7%				
Rank	Country	Nominal GDP (Billion US$)	Per Capita (US$)	GDP	2022 (US$)	CAGR	2040 (US$)	2022 (units)	CAGR	2040 (Units)
1	Egypt	398,397	3 770,13	398,40	52 760 000,00	7%	178 325 226,87	32 975,00	5%	72 824,59
2	Nigeria	390,002	1 755,33	390,00	563 093 000,00	7%	1 903 216 204,94	281 546,50	5%	621 789,47
3	South Africa	380,906	6 190,74	380,91	109 013 000,00	7%	368 456 557,17	68 133,13	5%	150 470,56
4	Algeria	224,107	4 874,71	224,11	51 024 000,00	7%	172 457 664,44	31 890,00	5%	70 428,39
5	Ethiopia	155,804	1 473,36	155,80	55 665 000,00	7%	188 143 930,13	34 790,63	5%	76 834,36
6	Morocco	147,343	3 979,87	147,34	108 826 000,00	7%	367 824 509,84	68 016,25	5%	150 212,44
7	Kenya	112,749	2 188,00	112,75	150 100 000,00	7%	507 327 834,59	93 812,50	5%	207 182,91
8	Angola	93,796	2 550,00	93,80	77 100 000,00	7%	260 592 778,46	48 187,50	5%	106 421,07
9	Tanzania	84,033	1 326,63	84,03	154 626 000,00	7%	522 625 408,07	96 641,25	5%	213 430,15
10	Ivory Coast	79,43	2 728,08			7%				
11	Ghana	76,628	2 328,97	76,63	52 500 000,00	7%	177 446 444,48	32 812,50	5%	72 465,71
12	Democratic Republic of the Congo	67,512	675,477			7%				
13	Uganda	52,39	1 163,03	52,39	156 613 000,00	7%	529 341 333,50	97 883,13	5%	216 172,80
14	Tunisia	51,271	4 190,60			7%				
15	Cameroon	49,262	1 721,95			7%				
16	Libya	40,194	5 872,22			7%				
17	Zimbabwe	32,424	2 005,88			7%				
18	Senegal	31,141	1 714,65	31,14	16 393 000,00	7%	55 407 229,80	10 245,63	5%	22 627,25
19	Zambia	29,536	1 435,89	29,54	9 039 000,00	7%	30 551 207,84	5 649,38	5%	12 476,52
20	Sudan	25,569	533,845							
21	Guinea	23,205	1 542,76							
22	Mozambique	21,936	647,135							
23	Mali	21,309	912,643							
24	Burkina Faso	20,785	888,029							
25	Botswana	20,756	7 758,37							
26	Benin	19,94	1 449,11							
27*	Gabon	19,319	8 831,82							
28*	Niger	17,073	630,8							
29*	Madagascar	15,763	529,56							
30*	Mauritius	14,819	11 751,51							
51*	Comoros	1,364	1 377,02							
--	Total	2 869,24	2 029,24	2 176,83	1 556 752 000,00		5 261 716 330,11	902 583		1 993 336
	*Note 51 countries are included			76%				Avg unit price		2 639,65
	ICE Two-Wheeler Market Assessment:				TOTAL	US $	6 935 354 062,43	Extrapolate for Africa (units)		2 627 373
	African Countries	13 Surveyed	51 Extrapolated							
	Units 2022	902 583	1 412 928							
	Units 2040 (7% CAGR)	1 993 336	2 627 373							
	Market Potential in 2040 (USD)	5 261 716 330	6 935 354 062							

Table 18: Electric Motorcycles Projected Market Demand for Africa

Electric Motorcycles Projected Market Demand For Africa											
					Select CAGR	30%					
Rank	Country	Nominal GDP (Billion US$)	Per Capita (US$)	GDP	2022 (US$)	CAGR	2040 (US$)	Unit price	2022 (units)	CAGR	2040 (units)
1	Egypt	398,397	3 770,13	398,40	574 000,00	30%	64 549 403,59	1 799,00	319	28%	25 297
2	Nigeria	390,002	1 755,33	390,00	217 000,00	30%	24 402 823,31	1 200,00	181	28%	14 337
3	South Africa	380,906	6 190,74	380,91	17 382 000,00	30%	1 954 699 883,64	3 500,00	4 966	28%	393 745
4	Algeria	224,107	4 874,71	224,11	34 000,00	30%	3 823 483,84	1 400,00	24	28%	1 925
5	Ethiopia	155,804	1 473,36	155,80	478 000,00	30%	53 753 684,52	1 400,00	341	28%	27 070
6	Morocco	147,343	3 979,87	147,34	6 961 000,00	30%	782 802 087,79	1 800,00	3 867	28%	306 607
7	Kenya	112,749	2 188,00	112,75	690 000,00	30%	77 594 230,80	1 200,00	575	28%	45 588
8	Angola	93,796	2 550,00	93,80	51 000,00	30%	5 735 225,75	1 200,00	43	28%	3 370
9	Tanzania	84,033	1 326,63	84,03	330 000,00	30%	37 110 284,29	1 200,00	275	28%	21 803
10	Ivory Coast	79,43	2 728,08				0,00				0
11	Ghana	76,628	2 328,97	76,63	80 000,00	30%	8 996 432,56	1 800,00	44	28%	3 524
12	Democratic Republic of the Congo	67,512	675,477				0				0
13	Uganda	52,39	1 163,03	52,39	24 000,00	30%	2 698 929,77	1 800,00	13	28%	1 057
14	Tunisia	51,271	4 190,60				0,00				0
15	Cameroon	49,262	1 721,95				0,00				0
16	Libya	40,194	5 872,22				0,00				0
17	Zimbabwe	32,424	2 005,88				0,00				0
18	Senegal	31,141	1 714,65	31,14	33 000,00	30%	3 711 028,43	1 800,00	18	28%	1 454
19	Zambia	29,536	1 435,89	29,54	67 000,00	30%	7 534 512,27	1 801,00	37	28%	2 949
20	Sudan	25,569	533,845								
21	Guinea	23,205	1 542,76								
22	Mozambique	21,936	647,135								
23	Mali	21,309	912,643								
24	Burkina Faso	20,785	888,029								
25	Botswana	20,756	7 758,37								
26	Benin	19,94	1 449,11								
27*	Gabon	19,319	8 831,82								
28*	Niger	17,073	630,8								
29*	Madagascar	15,763	529,56								
30*	Mauritius	14,819	11 751,51								
51*	Comoros	1,364	1 377,02								
--	Total	2 869,24	2 029,24	2 176,83	26 921 000,00		3 027 412 010,55		10 705		848 726
				76%					Avg unit price		3 567,01
	*Note 51 countries are included				TOTAL	US $	3 990 366 045,75		Extrapolate for Africa		1 118 687

Electric Two-Wheeler Market Assessment:		
African Countries	13 Surveyed	51 Extrapolated
Units 2022	10 705	13 300
Units 2040 (30% CAGR)	848 726	1 118 687
Market Potential in 2040 (USD)	3 027 412 011	3 990 366 046

Table 19: L-Class Vehicles Market Assessment for South Africa 1

L-CLASS VEHCILES MARKET ASSESSMENT

Legend	
Heading	
Input	
Results	
Calculated	

		Historical								Forecast										
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		H Year 1	H Year 2	H Year 3	H Year 4	H Year 5	H Year 6	H Year 7	H Year 8	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Cumulative African motor cycle market		16 200 000	17 142 255	18 342 213	19 809 590	21 295 310	22 785 981	24 042 900	25 725 903	27 526 716	29 453 586	31 515 337	33 721 411	36 081 910	38 607 643	41 310 179	44 201 891	47 296 023	50 606 745	54 149 217
Market growth			6%	7%	8%	8%	7%	6%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
Market segmentation	Percentages																			
2 wheeler	60%	9 720 000	10 285 353	11 005 328	11 885 754	12 777 186	13 671 589	14 425 740	15 435 542	16 516 030	17 672 152	18 909 202	20 232 847	21 649 146	23 164 586	24 786 107	26 521 135	28 377 614	30 364 047	32 489 530
3 wheeler	10%	1 620 000	1 714 226	1 834 221	1 980 959	2 129 531	2 278 598	2 404 290	2 572 590	2 752 672	2 945 359	3 151 534	3 372 141	3 608 191	3 860 764	4 131 018	4 420 189	4 729 602	5 060 675	5 414 922
4 wheeler	30%	4 860 000	5 142 677	5 502 664	5 942 877	6 388 593	6 835 794	7 212 870	7 717 771	8 258 015	8 836 076	9 454 601	10 116 423	10 824 573	11 582 293	12 393 054	13 260 567	14 188 807	15 182 024	16 244 765
Cumulative South African motor cycle market		230 900	245 900	256 900	267 400	283 900	303 500	325 500	349 500	377 000	406 500	437 500	469 000	501 000	534 000	568 000	604 200	641 200	679 900	719 900
Market growth			6%	4%	4%	6%	7%	7%	7%	8%	8%	8%	7%	7%	7%	6%	6%	6%	6%	6%
African market share		1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Market segmentation	Percentages																			
2 wheeler	70%	161 630	172 130	179 830	187 180	198 730	212 450	227 850	244 650	263 900	284 550	306 250	328 300	350 700	373 800	397 600	422 940	448 840	475 930	503 930
3 wheeler	5%	11 545	12 295	12 845	13 370	14 195	15 175	16 275	17 475	18 850	20 325	21 875	23 450	25 050	26 700	28 400	30 210	32 060	33 995	35 995
4 wheeler	25%	57 725	61 475	64 225	66 850	70 975	75 875	81 375	87 375	94 250	101 625	109 375	117 250	125 250	133 500	142 000	151 050	160 300	169 975	179 975
South Africa delivery market																				
2 wheeler	25%	40 408	43 033	44 958	46 795	49 683	53 113	56 963	61 163	65 975	71 138	76 563	82 075	87 675	93 450	99 400	105 735	112 210	118 983	125 983
Market growth			6%	4%	4%	6%	7%	7%	7%	8%	8%	8%	7%	7%	7%	6%	6%	6%	6%	6%
Delivery Two-Wheeler Cumulative Market Growth South Africa		0%	6%	11%	16%	23%	31%	41%	51%	63%	76%	89%	103%	117%	131%	146%	162%	178%	194%	212%

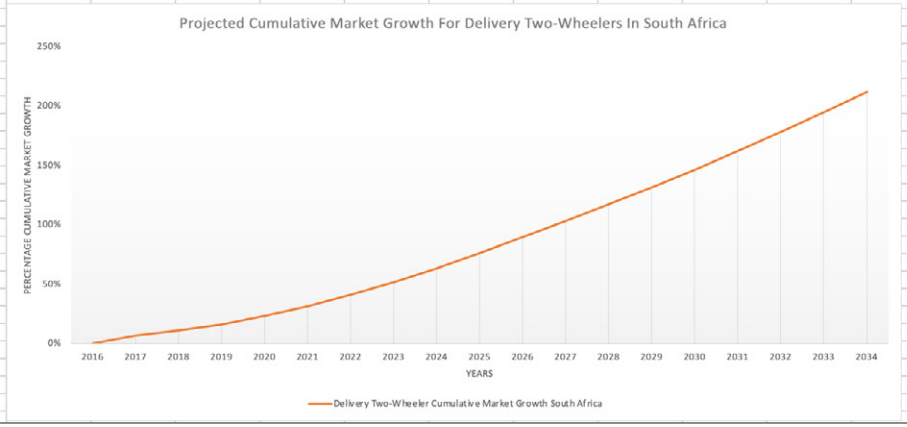


Table 20: L-Class Vehicles Market Assessment for South Africa 2

L-CLASS VEHCILES MARKET ASSESSMENT

Legend																				
Heading																				
Input																				
Results																				
Calculated																				
		Historical								Forecast										
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		H Year 1	H Year 2	H Year 3	H Year 4	H Year 5	H Year 6	H Year 7	H Year 8	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Additional new 2 wheeler segmentation per annum																				
ICE		100,0%	100,0%	100,0%	100,0%	100,0%	99,0%	97,0%	95,0%	93,0%	90,0%	87,5%	85,0%	82,5%	80,0%	77,5%	75,0%	72,5%	70,0%	67,5%
Electric		0,0%	0,0%	0,0%	0,0%	0,0%	1,0%	3,0%	5,0%	7,0%	10,0%	12,5%	15,0%	17,5%	20,0%	22,5%	25,0%	27,5%	30,0%	32,5%
New market sales		40 408	2 625	1 925	1 838	2 888	3 430	3 850	4 200	4 813	5 163	5 425	5 513	5 600	5 775	5 950	6 335	6 475	6 772	7 000
ICE		40 408	2 625	1 925	1 838	2 888	3 396	3 735	3 990	4 476	4 646	4 747	4 686	4 620	4 620	4 611	4 751	4 694	4 741	4 725
Electric		-	-	-	-	-	34	116	210	337	516	678	827	980	1 155	1 339	1 584	1 781	2 032	2 275
Replacement market																				
Life expectancy delivery 2 wheeler	Years																			
Replacement schedule																				
ICE	5	0	0	0	0	0	2100	-543	-66	761	380	284	228	158	158	144	46	44	83	79
Electric	7	0	0	0	0	0	0	0	0	0	289	163	137	123	131	149	149	42	44	92
Total delivery market																				
ICE		40 408	2 625	1 925	1 838	2 888	5 496	3 192	3 924	5 237	5 026	5 030	4 913	4 778	4 778	4 756	4 797	4 738	4 824	4 804
Electric		0	0	0	0	0	34	116	210	337	805	841	963	1 103	1 286	1 488	1 733	1 822	2 076	2 367
Total market		**40 408**	**2 625**	**1 925**	**1 838**	**2 888**	**5 530**	**3 308**	**4 134**	**5 574**	**5 831**	**5 871**	**5 877**	**5 880**	**6 064**	**6 243**	**6 530**	**6 560**	**6 899**	**7 171**
Electric market growth																				
Electric growth			0%	0%	0%	0%	100%	337%	182%	160%	239%	104%	115%	114%	117%	116%	116%	105%	114%	114%
Cumulative		-	0	0	0	0	34	150	360	697	1 502	2 343	3 306	4 408	5 695	7 182	8 915	10 737	12 812	15 179
Growth			0%	0%	0%	0%	100%	337%	140%	94%	116%	56%	41%	33%	29%	26%	24%	20%	19%	18%
Electric Delivery Two-Wheeler Market Growth In South Africa		0%	0%	0%	0%	0%	100%	437%	577%	671%	786%	842%	883%	917%	946%	972%	996%	1016%	1036%	1054%

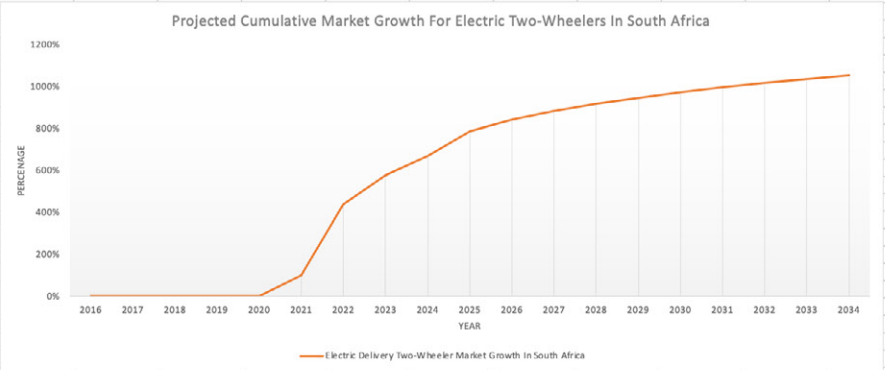


Table 21: L-Class Vehicles Value Chain Volumes Assessment for South Africa

L-CLASS VEHCILES MARKET ASSESSMENT

Legend	
Heading	
Input	
Results	
Calculated	

		Historical								Forecast										
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		H Year 1	H Year 2	H Year 3	H Year 4	H Year 5	H Year 6	H Year 7	H Year 8	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Value chain volumes																				
Electric	Number																			
Steel frame	1	-	-	-	-	-	34	116	210	337	805	841	963	1 103	1 286	1 488	1 733	1 822	2 076	2 367
Harness	1	-	-	-	-	-	34	116	210	337	805	841	963	1 103	1 286	1 488	1 733	1 822	2 076	2 367
Tyres	2	-	-	-	-	-	69	231	420	674	1 610	1 682	1 927	2 205	2 573	2 975	3 465	3 644	4 151	4 734
Rims	2	-	-	-	-	-	69	231	420	674	1 610	1 682	1 927	2 205	2 573	2 975	3 465	3 644	4 151	4 734
Brake system	2	-	-	-	-	-	69	231	420	674	1 610	1 682	1 927	2 205	2 573	2 975	3 465	3 644	4 151	4 734
Front shocks	2	-	-	-	-	-	69	231	420	674	1 610	1 682	1 927	2 205	2 573	2 975	3 465	3 644	4 151	4 734
Back shocks	2	-	-	-	-	-	69	231	420	674	1 610	1 682	1 927	2 205	2 573	2 975	3 465	3 644	4 151	4 734
Electric drive system	1	-	-	-	-	-	34	116	210	337	805	841	963	1 103	1 286	1 488	1 733	1 822	2 076	2 367
Controls	1	-	-	-	-	-	34	116	210	337	805	841	963	1 103	1 286	1 488	1 733	1 822	2 076	2 367
Battery	1	-	-	-	-	-	34	116	210	337	805	841	963	1 103	1 286	1 488	1 733	1 822	2 076	2 367
BMS system	1	-	-	-	-	-	34	116	210	337	805	841	963	1 103	1 286	1 488	1 733	1 822	2 076	2 367
Auxiliary system	1	-	-	-	-	-	34	116	210	337	805	841	963	1 103	1 286	1 488	1 733	1 822	2 076	2 367
Battery needs																				
Delivery 2 wheeler distance per day	125																			
Days per annum	365																			
Average kilometers per battery	125																			
Charging time for battery (hours)	2																			
2 wheeler operating hours per day	12																			
Available swops per operating hours	6																			
Batteries per 2 wheeler	1,0																			
Cycles per battery	4000																			
Battery life at 1 cycle per day (years)	11,0																			
More batteries than usage	True																			
Total operating new electric delivery vehicles		-	-	-	-	-	34	116	210	337	805	841	963	1 103	1 286	1 488	1 733	1 822	2 076	2 367
Batteries required per day		-	-	-	-	-	34	116	210	337	805	841	963	1 103	1 286	1 488	1 733	1 822	2 076	2 367
Cumulative battery pack excluding replacement									360	697	1 502	2 343	3 306	4 408	5 695	7 182	8 915	10 737	12 812	15 179
Batteries required per day									360	697	1 502	2 343	3 306	4 408	5 695	7 182	8 915	10 737	12 812	15 179

17. Annexure E: Last Mile Deliveries

17.1 Two-Wheeler Light Deliveries

An initial investment in a NEV scooter enables superior technology that leads to improved performance in the form of improved energy efficiency, lower operating costs, no harmful exhaust emissions and a longer service life. This leads to lower total cost of ownership in the long term. This issue of higher initial costs would need to be addressed in supporting the transition to electric propulsion. For Example: [91,92]



Figure 29: Checkers Sixty60 Last Mile Deliveries

The figure above shows a petrol motorcycle at R20 000 used for Checkers Sixty60 deliveries.

- This brings Checkers revenue of R10-13 billion.
- The average delivery return trip is 7.5km and cost the customer R35.00.
- If the customer made the trip it will cost about R53.00. That is R18.00 more.
- A driver executes on average 15 trips per day or 113km in total per day.
- Fuel consumption is 2.4litres/100km
- Maintenance every 3 000km at a cost of R700.
- A electric scooter could last double the years of a petrol scooter[93] (Ola scooters have an eight year or 80 000km warrantee)

Suppose the price of the complete electric motorbike is R70 000 and the battery is R25 000. If the cost of the battery is deducted from the purchase cost, the user can buy the motorbike for R45 000. This saving may be less than expected. The lower energy costs make a much greater contribution to reducing the total cost of ownership.

[91] https://www.shopriteholdings.co.za/articles/Newsroom/2022/its-cheaper-to-get-it-delivered-sixty60.html
[92] https://dailyinvestor.com/retail/46201/checkers-sixty60-revenue-estimate-and-it-is-eye-wateringly-high/#:~:text=To%20triple%2Dcheck%20the%20number,estimated%2015%20trips%20a%20day.
[93] https://economictimes.indiatimes.com/industry/renewables/ola-scooters-to-have-double-lifespan-compared-to-petrol-scooters-says-bhavish-aggarwal-announces-8-year-warranty/articleshow/107352688.cms?from=mdr

Table 22: Example Calculations

Assumptions	Petrol Scooter		Electric Scooter		Battery	
Price	R20,000		R70,000		R25,000	
Energy Cons	2.4	L/100km	3		5	kWh
Maintenance	R700	every 3000km	R70		R0	
Life	4	years	8	years	8	years
Distance/day	113	km	113	km		
Days/year	300	days				
Energy Price	R25		R3			
Income/trip	R30		R30			
One trip	7.50	km	7.50	km		

Calculations	Petrol		Electric		No Battery	
Distance/year	33900		33900		33900	
Energy Cons	2.4	L/100km	3		5	kWh
Energy cost/year	R20,340		R3,051		R6,176	
Maintenance/year	R7,910		R791		R791	
Costs/year	R28,250		R3,842		R6,967	
Trips/year	4520		4520			
Income per year	R135,600		R135,600		R135,600	
Difference	R107,350		R131,758		R128,633	

The following NPV calculations were performed to compare the cash flows for the two-wheeled delivery vehicle options: Petrol, electric and no battery.

Table 23: Two Wheel Delivery NPV Calculations

NPV Calculations				Lease/Rent
				15%
	Petrol	Electric	Battery Removed	Rental
Year 0	(R20,000)	(R70,000)	(R45,000)	(R10,063)
Year 1	(R28,250)	(R3,842)	(R6,967)	(R13,114)
Year 2	(R28,250)	(R3,842)	(R6,967)	(R13,114)
Year 3	(R28,250)	(R3,842)	(R6,967)	(R13,114)
Year 4	(R28,250)	(R3,842)	(R6,967)	(R13,114)
Year 5	(R28,250)	(R3,842)	(R6,967)	(R13,114)
Year 6	(R28,250)	(R3,842)	(R6,967)	(R13,114)
Year 7	(R28,250)	(R3,842)	(R6,967)	(R13,114)
Year 8	(R28,250)	(R3,842)	(R6,967)	(R13,114)
NPV	(R184,365)	(R88,545)	(R83,268)	(R86,316)
* ( ) indicates negative numbers				

It is clear from the table above that the cash flow in terms of net present value is much higher for the petrol scooter than for the electric scooter. In this case, the elimination of the cost of the scooter's battery did not result in significant savings for the rider. The high purchase price of the electric scooter could be too high for many riders. Renting the electric scooter may then make sense.

The operating costs of the electric alternative are much lower than the operating costs of a petrol scooter due to the lower maintenance requirements, longer service life and lower energy consumption. This means that the rental costs mainly depend on the purchase price of the vehicle, which is spread over the life expectancy of the vehicle. The longer expected life of the electric vehicle should help to reduce rental costs.

To support the transition to NEVs in this market, the option of using electric vans instead of petrol-powered vans should be made more attractive. This can be done by improving the availability of the electric alternative.

17.1.1 Investment Opportunities in Electric Two-Wheelers

Two wheelers are not only used for deliveries, but oftentimes is the point of entry for many into individual urban mobility.

There are several areas that could be supported as discussed in the table below.

Table 24: Investment Opportunity Area for Two-Wheelers

Opportunity Area	Purpose
Establishing Electric Two-Wheeler Manufacturing Business	It is not difficult to manufacture electric motorcycles as depicted in the figure below.
Establishing Electric Two-Wheeler Rental Business	Reducing upfront cost.
Establishing a Battery Swapping Service Network	Supporting electric two-wheeler operations. This can be scaled to also support three and four wheelers.

The figure below shows electric two-wheelers that consist of very few and elementary components. Simple designs like these ensure a simple manufacturing and assembly process which enables a cost-effective manufacturing process and a low-cost product.



Figure 30: Two-Wheeler Design Example

17.1.1.1 Motorcycle Conversions

Petrol motorbikes can be converted to electric ones by buying motors, control units and batteries online that replace the petrol drivetrain and fuel tank. In-wheel motors are also available for purchase. This conversion process is already taking place in Kenya.

Lower barriers to entry could simplify the process of vehicle conversion without compromising the quality and safety standards of the vehicle. This will also encourage private sector participation in the industry and enable a faster learning process.



Figure 31: E-Motorcycle Conversion Kit Example

17.2 Three-Wheeler Light Deliveries

MellowVans is a South African company that develops and manufactures three-wheeled electric vehicles. The vehicles are designed to provide an efficient delivery service in urban areas. MellowVans' three-wheeled vehicle offers 10 times the delivery capacity (2.5m^3) of a typical delivery motorbike (0.25m^3).

Specially developed, scalable lithium batteries provide a high energy density that is safe to use, while the 48V motor delivers maximum thrust. The three-wheeled vehicle has a range of around 120 km. The in-built, actively cooled chargers allow for easy charging when plugged into standard 230V household sockets.

MellowVans offers an innovative and environmentally friendly advertising medium. The electric delivery vehicle offers location-specific, mobile billboard advertising exactly where it is needed and, even better, potential revenue from the advertising income generated.

17.3 Four-Wheeler Larger Volume Deliveries

The electric L Class, L7 type vehicle is the ideal small urban delivery vehicle. Just recently Checkers started to explore the bigger delivery vehicle option with Nissan NV200 vans.

Sixty60, Shoprite's on-demand delivery service for its Checkers brand, is piloting a new service which allows customers to shop for more than 10 000 larger products from its Hyper division, from small appliances to home electronics. SA's largest retailer will also still provide same day delivery within a 60-minute time slot, using a new fleet of delivery vans to reach its customers, as it again looks to disrupt the on-demand space as it did with the app's initial launch.

This new offering will extend beyond groceries to include larger items, ranging from camping and outdoor gear to small appliances, baby products, toys, kitchen and home electronics, to gardening and pool equipment at supermarket prices. The pilot is currently able to serve customers living in the certain areas in Cape Town.



Figure 32: Checkers Sixty60 Vans

The pilot project is currently able to deliver to customers living in certain areas of Cape Town. These delivery services can also be carried out with a slightly smaller L7 vehicle. A cost comparison between ICEs and electric four-wheelers shows that the cost per year for an ICE is R33 000, while electric four-wheelers cost R4 650 per year.

Table 25: Cost Comparison of Four-Wheel Delivery Vehicles

Assumptions	Petrol Car/LDV		L 7 Class Light EV		Battery Alone	
Price	R250,000		R350,000		R100,000	
Energy Cons	8	L/100km	(5 to) 10		25	kWh
Maintenance	R3,000	15000	R300		R0	
Life	5	years	10	years	10	years
Energy Price	R25		R3			
Rental	R6,000	/month				

Assumptions	Petrol Car/LDV		L 7 Class Light EV	
Distance/year	15,000	km	15,000	km
Energy cost/year	R30,000		R4,500	
Maintenance/year	R3,000		R150	
Costs/year	R33,000		R4,650	

Using the numbers from the comparison calculations (without inflation), a net present value comparison was done for a period of 10 years in the table below.

Table 26: Four Wheel Delivery NPV Calculations

NPV Calculations				Lease/Rent
				15%
	Petrol	Electric	No Battery	Rental
Year 0	(R250,000)	(R350,000)	(R250,000)	(R40,250)
Year 1	(R33,000)	(R4,650)	(R14,650)	(R44,750)
Year 2	(R33,000)	(R4,650)	(R14,650)	(R44,750)
Year 3	(R33,000)	(R4,650)	(R14,650)	(R44,750)
Year 4	(R33,000)	(R4,650)	(R14,650)	(R44,750)
Year 5	(R183,000)	(R4,650)	(R14,650)	(R44,750)
Year 6	(R33,000)	(R4,650)	(R14,650)	(R44,750)
Year 7	(R33,000)	(R4,650)	(R14,650)	(R44,750)
Year 8	(R33,000)	(R4,650)	(R14,650)	(R44,750)
Year 9	(R33,000)	(R4,650)	(R14,650)	(R44,750)
Year 10	(R33,000)	(R4,650)	(R14,650)	(R44,750)
NPV	**(R570,728)**	**(R362,476)**	**(R337,571)**	**(R348,692)**
* ( ) indicates negative numbers				

Assuming the ICE vehicle needs replacement after 5 years and selling the old vehicle for R150 000, the NPV for the ICE cash outflows is R208 252 higher than for the electric vehicle making it more expensive to own. Renting the electric vehicle saves an additional R13 784 and not paying for the battery upfront and preferring a lease saves another R24 905 compared to paying upfront for the vehicle and battery energy storage.

17.4 Niche Markets

The electric small 4-wheeler can also be used in a variety of other niche markets as a utility electric vehicle. Eleksa is a company that deals exclusively with the assembling and accessorising of light electric vehicles for niche markets such as:

- A small tractor in packing houses.
- A small tractor in vineyards and orchids.
- A small bakkie on farms.
- A small supervisor car in mining.
- A small game viewing vehicle
- A service vehicle for municipality service work (the battery also powering power tools).
- An urban commuter car for the city.

Since their inception, Eleksa's business model has been to specialise in the assembly and accessorising of their electric L-class vehicles. Eleksa has successfully established a marketing and distribution footprint with sales volumes that makes it economic to assemble light electric vehicles in South Africa. The company's goal is to expand their assembly capabilities, and they are looking for partners to invest in automotive production assets and technology that will enable them to assemble electric L-class vehicles at industrial scale. The company is also in the process of developing a business case for the localisation of several components for their electric L-class vehicles.

Eleksa has proven that there is a market for L-class electric vehicles in South Africa. They currently import complete built units (CBU) from China, selling around 100 units per month and is looking to expand their sales to 150 units per month.



Figure 33: Niche Market for Electric L-Class Vehicles

The above vehicles can either charge their batteries from a wall socket or conventional charge point but can also make use of the same battery swapping system as for the two wheelers. This method of choice will depend on the operational characteristics of the vehicle and the market application.

Having a single battery standard determining the battery size and connectors means the swapping system can be standardised and scaled. This means cost reductions and sustainable operations.

The figure below shows energy storage needs of four L Class vehicles of different size. For example, the Nissan Twizzy 4-wheeler needs a battery about double the size of the Gogoro 2-wheeler.

	Battery Capacity	Motor Power	Range	Max Speed
 GenZe eBike	0.3kwh	250 W (0.5hp)	30 miles (48 km)	20mph (32 kph)
 Genze 2.0 Scooter	1.6wh	1kW (2hp)	30 miles (48 km)	30 mph (48kph)
 Gogoro Scooter	2.6wh	7kW (9.5hp)	62 miles (100 km)	60 mph (95kph)
 Nissan Twizy	6.1wh	13kW (17hp)	50 miles (80 km)	50 mph (80kph)

Figure 34: Energy Storage Needs of L-Class Vehicles

17.5 Battery Considerations for L-Class Vehicles[94]

The dimensions and energy content of the batteries vary between different vehicles. For each type of vehicle, different forces act on the battery's locks, connections and internal parts. In a seated scooter, for example, the module is usually firmly seated in its compartment in a vertical position and can be replaced from above. On an electric bike or a stand-up scooter, the battery may be attached to the outside of the frame.

Almost all replaceable batteries in the world are equipped with programmable IoT-supported controllers. This enables not only proper control, charging and maintenance of the battery, but also remote tracking and status feedback.

Gogoro, for example, the company that has become the de facto standard for swappable batteries in light electric vehicles, has launched three generations of batteries that are compatible with all its stations and vehicles, regardless of when they were manufactured. While the company estimates that its third-generation modules will last around twenty years, the company has just unveiled the world's first prototype of a replaceable solid-state battery for electric vehicles.

The battery was developed in partnership with ProLogium Technology, a leading supplier of solid-state batteries specialising in lithium-ceramic batteries (LCBs).

It is expected to go into mass production by 2025 or 2026 to be used alongside older LNMC batteries. Thank you to the higher energy density of the solid-state modules, small city cars can also be included in the system, as planned by the centre.

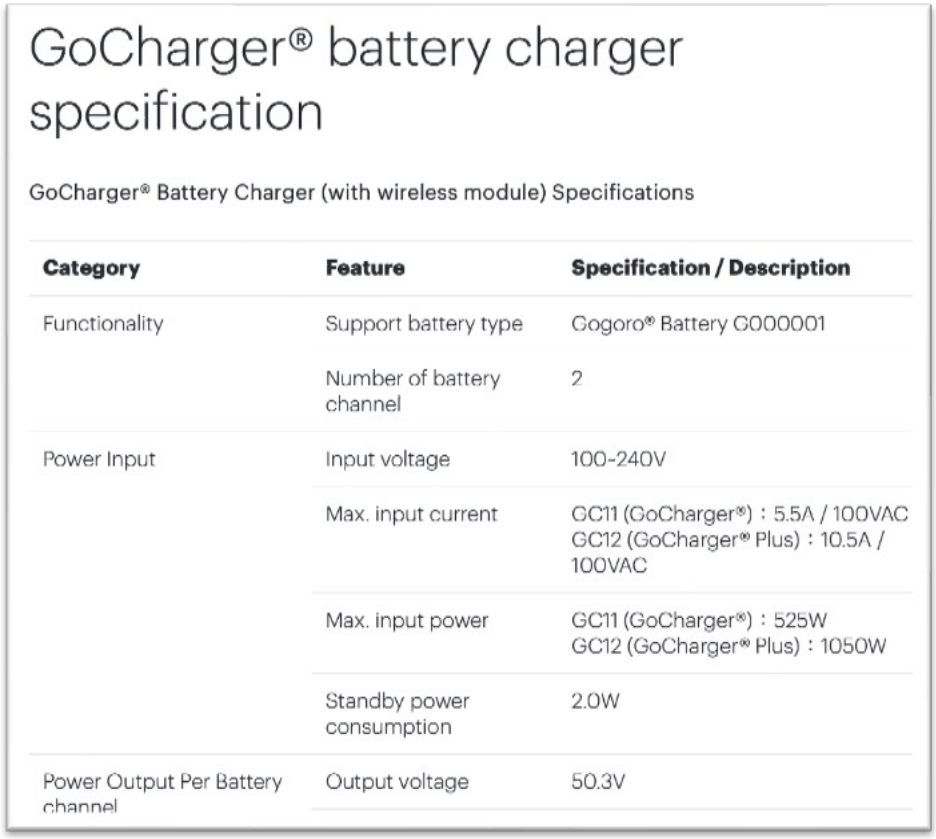
In exchange services for private e-scooters, e-bikes and trikes and even microcars, the batteries are moved by the users of the services. For this reason, they should weigh around 10 kg. Since a battery is the most visible part of

[94] https://www.batterydesign.net/designing-swappable-batteries/

an operator's brand, it should have an attractive appearance. Its shape should also prevent incorrect insertion. The housing must provide strong protection against vandalism, theft, impact from falling and water ingress. Having a standard battery for use in 2-wheelers, 3-wheelers as well as 4-whelers enables to achieve scale and keep costs low.

Reaching the end of life in mobility, these packs are gradually re-purposed for other applications. The Taiwanese operator is working on a backup system to power parking meters, traffic lights and 5G cells and other applications where portability makes sense.

Together with the battery design comes the design of the swapping system. This is where the batteries are stored while charging waiting for the net user swap. The Gogoro system provides good guidance in this case. GoGoro Charger specification are shown in the figure below.[95]



GoCharger® battery charger specification

GoCharger® Battery Charger (with wireless module) Specifications

Category	Feature	Specification / Description
Functionality	Support battery type	Gogoro® Battery G000001
	Number of battery channel	2
Power Input	Input voltage	100-240V
	Max. input current	GC11 (GoCharger®) : 5.5A / 100VAC GC12 (GoCharger® Plus) : 10.5A / 100VAC
	Max. input power	GC11 (GoCharger®) : 525W GC12 (GoCharger® Plus) : 1050W
	Standby power consumption	2.0W
Power Output Per Battery channel	Output voltage	50.3V

Figure 35: GoCharger Specifications

The supply option of choice for electric L-Class delivery vehicles is a battery swapping system (of course, the option to recharge these batteries at home or depot remains). These batteries currently store between 1,8kWh-2,5kWh of electrical energy.

Below are pictures of the Valtenergy system. It is suggested that a similar standardised system be developed locally. South Africa has several battery assembly operations that could easily produce the standard battery packs for use in all types of L-Class EVs and battery swapping stations. The swapping stations can also be produced locally.

[95] https://support.gogoro.com/en/manual/collections/7736206749587736/articles/115009247987/



Figure 36: Valtenergy System

18. Annexure F: Overview of Special Economic Zones

This annexure includes background information and an overview of all operational SEZs in South Africa.

18.1 Atlantis SEZ (Manufacturing, Converting, Assembly and Recycling)

The Atlantis SEZ located in the Western Cape focuses primarily on green technology and therefore there are incentives to manufacture and convert EVs as well as assembly and recycle batteries on its premises. There exists synergies and knowledge sharing relationships between different industries operating in the green technology space that can be beneficial when entering the electronic technology market.

The following information was extracted in the Atlantis SEZ's annual report for 2022/2023[96].

- Post Covid and Russia's invasion of Ukraine there is an emphasis of the necessity for renewable energy and locally produced products. Investments into renewable energy experienced a surge due to the increasing impact of loadshedding and the removal of the cap on embedded generation in South Africa. The ASEZ's focuses on Greentech in its investment targeting, as well as its approach to running and maintaining a green and sustainable industrial zone means its value proposition sits comfortably with the realities of the current operating environment.
- The ASEZs place an importance in proving their tenants with energy security. In partnership with GreenCape, and through a project funded by Bloomberg, SEZ is exploring how it can provide complete energy security to its tenants. This initiative is closely aligned to the City of Cape Town's and WCG's move to bring new energy onto the grid. The ASEZCo will continue to install rooftop solar and some battery storage with the construction of each new factory.

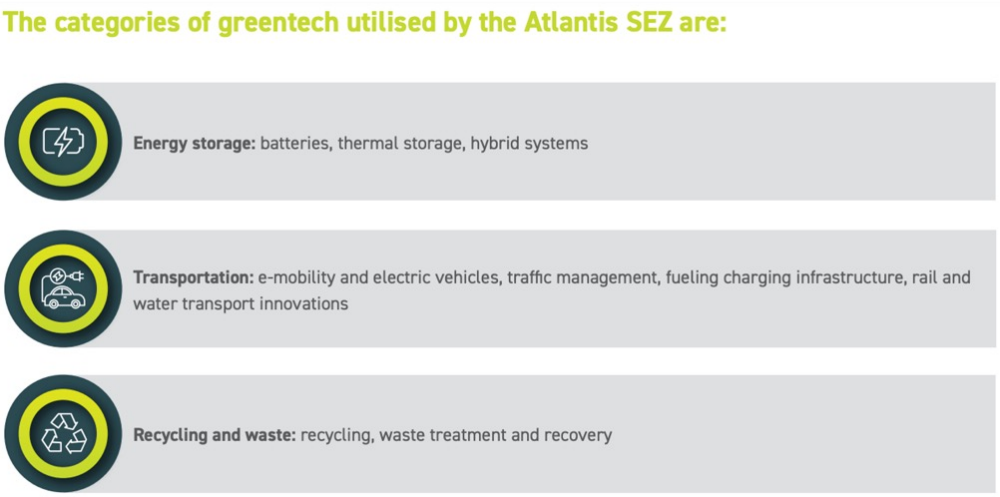


Figure 37: Categories of Greentech Utilised by Atlantis SEZ (adapted)[97]

As seen in the figure above, the ASEZ places emphasis on the categories relevant to this report namely, batteries, e-mobility and electric vehicles, as well as recycling.

The major disadvantage of Atlantis is its location. There is an existing 43km long rail that connects the SEZ and the Port of Cape Town directly, however it is not currently operational. To reinstate the rail service, it requires servicing and upgrades by Transnet and could cost upwards of R40 million[98]. The proximity to the port and Cape Town is advantageous, however, there are currently no existing OEMs nearby and therefore it's logistically complicated and expensive to transport components throughout South Africa from/to Atlantis SEZ.

[96] Atlantis Special Economic Zone. Annual Report. 2023. https://www.wcpp.gov.za/sites/default/files/Atlantis%20Special%20Economic%20Zone%202022_2023%20Annual%20Report%20Final.pdf
[97] Atlantis Special Economic Zone. Annual Report. 2023. https://www.wcpp.gov.za/sites/default/files/Atlantis%20Special%20Economic%20Zone%202022_2023%20Annual%20Report%20Final.pdf
[98] Cape Business News. 2024. https://www.cbn.co.za/industry-news/rail-infrastructure-development/will-cost-about-r40m-to-get-atlantis-sez-rail-line-operational/

This is especially important to take note of in terms of manufacturing and converting EVs.

18.2 Coega SEZ (Manufacturing and Converting)[99]

The Coega SEZ, the largest SEZ, is situated by the Port of Ngqura in Port Elizabeth, which enables easy importing and exporting components and finished goods. Coega SEZ is located near Volkswagen, Ford Motors and General Motors, which allows for an established supply chain of component suppliers to be utilised in the area.

Component suppliers include[100]:

- Faurecia Interior Systems,
- Grupo Antolin, Hella,
- Inergy Automotive Systems,
- MICB Automotive,
- Q-Plas Automotive,
- Rehau Automotive,
- Schenellecke Automotive, and
- VSL Manufacturing Benteler Automotive.

The abundance of such suppliers warrants the availability of components utilized for ICE vehicles that can be reused in the manufacturing of electric vehicles.

Coega SEZ is also implementing projects to accelerate their vision of making Coega and the NMBLP building greener. The initial phase of the solar rooftop project involves installing 4.5 MW photovoltaic (PV) systems on the rooftops of five buildings within the Coega SEZ and Nelson Mandela Bay Logistics Park (NMBLP). In 2023, the first building, the Coega Business Process Outsourcing (BPO) Park, was fitted and commissioned, with roof assessments and designs approved for the remaining four buildings.

The Coega SEZ Energy Strategy outlines options for managing energy supply, demand, efficient usage, and investment in current and new energy technologies in an environmentally friendly, institutionally sound, socially acceptable, and cost-effective manner. This strategy enhances the Coega SEZ's value proposition as a leading African investment destination and a gateway to world markets. Key initiatives include a 24-hour load curtailment schedule, opportunities for solar rooftop power generation, the development of a solar farm within the Coega SEZ, and another in the NMBLP. These locations were chosen for their available land, electrical distribution networks, capability to transmit electricity to external customers via wheeling agreements, and excellent solar and wind resources.

18.3 East London IDZ (Manufacturing, Converting, Assembly and Recycling)[101]

The East London IDZ is a key location for the automotive manufacturing investment in South Africa since it houses an Automotive Supplier Park (ASP). The operational ASP supplies local OEMs, namely Mercedes Benz, Toyota, Volkswagen and Ford[102]. Components and services that are currently being manufactured and rendered in the ASP include[103]:

[99] Coega. Integrated Annual Report. 2023. https://coega.co.za/site/assets/documents/document-library/2023/Integrated_Annual_Report/Report_2022-23.pdf
[100] Investment Monitor. Coega SEZ is becoming a hub for the automotive industry. 2023.
https://www.investmentmonitor.ai/sponsored/how-south-africas-coega-sez-is-becoming-a-hub-for-the-automotive-industry/#:~:text=The%20Coega%20SEZ%2C%20inclusive%20of,%2DPlas%20Automotive%2C%20Rehau%20Automotive%2C
[101] ELIDZ. Renewable Energy. https://www.elidz.co.za/renewable-energy/
[102] GlobalAfrica. Top locations for manufacturers and suppliers in the automotive sector. 2023.
https://www.investmentmonitor.ai/sponsored/how-south-africas-coega-sez-is-becoming-a-hub-for-the-automotive-industry/#:~:text=The%20Coega%20SEZ%2C%20inclusive%20of,%2DPlas%20Automotive%2C%20Rehau%20Automotive%2C
[103] ELIDZ. Automotive Manufacturers. 2024. https://www.elidz.co.za/wp-content/uploads/2015/01/ELIDZ-BROCHURE-single-pages.pdf

- Cock pit.
- Brake and fuel pipes.
- Fuel tanks.
- Suspension components.
- Polypropylene impact dampers.
- Wheelhouse liners.
- Tyres and rims.
- Moulded floor carpets and loose mats.
- Boot liners.
- Parcel trays.
- Headliners.
- Sun visors.
- Seat components.
- Various injection moulded plastic parts.
- Exhaust Systems.
- E-coating and Aluminium pre-treatment.
- Various metal pressing and joining.

Most of the components mentioned above can be reused to manufacture an electric vehicle. The component suppliers are sourced directly from within and around the ELIDZs premises which allows for short lead times and a quick entry to market since their operations and supply chain is already established. The ELIDZs location by the port also provides an advantage as importing and exporting components are simpler and at a lower cost.

One of the primary focus sectors for ELIDZ is the renewable energy sector. ELIDZ's strategy in this sector is two-pronged, aiming to attract investors in both renewable energy manufacturing and the production and transfer of green power.

The ELIDZ is a pilot park receiving detailed technical assistance through the Global Eco-Industrial Parks Programme. As a "model lighthouse" industrial park in South Africa, ELIDZ already boasts a high level of eco-industrial performance and is dedicated to continuous improvement processes to fully transform into an eco-industrial park that meets international standards.

1. Excellent Conditions for Production and Transfer of Renewable Energy

ELIDZ facilitates the establishment of renewable energy projects within its industrial park, which is situated on land with favorable wind and solar characteristics. This strategic location supports tenants by providing access to renewable energy services such as:

- Ideal wind conditions for the generation of wind energy.
- Flat land with ideal sunny conditions for solar energy generation.
- Excellent growth conditions for biofuel feedstock.
- Strong links with the local authority with a potential ease of access to the municipal electricity grid.
- Established links with the top 100 electricity users in the Buffalo City Metropolitan Municipality as a potential market for green energy.

- A green IDZ, with good ICT connectivity and logistical infrastructure supported by the availability of affordable labour and a strong manufacturing base.
- Access to secure and stable green energy
- Cost effective, reliable, sustainable, and high-quality water supply available to investors.
- Supportive cluster to feed into your business processes.
- Strong green ambitions and offers a range of shared services to investors (e.g. ICT, clinic, Science and Technology Park.
- Offers a modern customized space in a technology enabled zone which is ready for future smart requirements and where connectivity is fast.
- Offers great connectivity and is powered by renewable energy.

2. Packaged Energy Generation Projects

ELIDZ has developed strategic energy generation projects that maximize the use of existing infrastructure, leverage institutional partnerships with key stakeholders, and capitalize on its locational advantages.

- ELIDZ 50MW Solar PV Project
  This 50 MW photovoltaic (PV) Solar farm forms part of a wider ELIDZ Eco-Industrial Park Programme. Investment in a PV solar facility will provide the ELIDZ ecosystem with a reliable alternative power supply with energy security at competitive rates.
- Grid Energy System
  Two off-grid energy storage (battery) systems capable of supplying a total capacity of two (2) Megawats (MW) to three (3) MW hr connected to one of the main 11 kV substations within the ELIDZ 11 kV infrastructure. The aim is to reduce the SEZ's operating electrical load by 20% for the duration of the national load shedding cycles.
- Hoodpoint Wastewater Reclamation Works
  An all-encompassing environmentally friendly water recycling and bio fertilizer manufacturing project. The Pre-Feasibility study has already been undertaken and completed.
- ELIDZ 1.8MW Wind Farm
  The project is a 1.8 MW Wind Farm Power Generation project to be part of a wider ELIDZ smart solutions and Eco-Industrial Park Programme. The Pre-Feasibility study has already been undertaken and completed.
- Berlin SEZ Extension
  ELIDZ will build an industrial complex in Berlin that will focus on specialized fields such as agro-processing, automotive manufacturing, and biofuels production. It's worth noting that existing infrastructure exists, albeit in a state of disrepair. The existing park in Berlin's industrial precinct is currently operational and has already demonstrated a high potential for immediate investment.

3. Tailored Skills Development Initiatives to Support the Growing Renewable Energy Sector and the Science & Technology Park

Through its Science and Technology Park, the ELIDZ has partnered with the Master Artisans Academy of South Africa (MAASA) to establish a state-of-the art Renewable Energy Centre of Excellence. The centre offers various internationally accredited training programmes to support the growing renewable energy sector. These programmes include:

- Training electricians and electrical engineers in the installation of photovoltaic systems
- Solarteur Training Programme, an 18-month certified programme for renewable energy professions. This is an international Solarteur certification in accordance with EU guideline EG 2008/29. The ELIDZ Science and Technology Park (ELIDZ STP) has the only accredited Solateur School in South Africa.

4. Proven Renewable Energy Incubation and Testing Platform

Through the ELIDZ Science and Technology Park (STP), ELIDZ is actively engaged in testing and prototyping various renewable technologies and new inventions. ELIDZ STP provides a platform that encourages innovators and startups to establish themselves within the ELIDZ, offering access to various innovation funders and a facilitated incubation process and facilities.

The ELIDZ STP aims to facilitate creative and technical solutions to challenges, helping companies adopt innovative approaches in their operations. This can lead to new products and services or improved versions of existing offerings through enhanced processes.

This platform has already fostered the development of several new renewable energy technologies, including:

- Twerly, an innovative streetlight powered by green energy.
- Heat Raider.
- Solar Water Desalination.

The successful development of these prototypes demonstrates the ELIDZ innovation ecosystem's ability to generate new technologies that work and contribute to increasing industry outputs.

18.4 Dube Tradeport SEZ (Manufacturing, Converting, Assembly and Recycling)[104]

The Dube Tradeport SEZ stands as a pivotal hub for global trade, serving as a gateway between KwaZulu-Natal and the international market. Distinguished as the sole facility on the continent to integrate an international airport, cargo terminal, warehousing, offices, retail sector, hotels, and agricultural area, it offers a comprehensive infrastructure unmatched in Africa. These factors enable seamless and cost-effective importing and exporting of components. Dube Tradeport SEZ is currently supplying and working in conjunctures with Toyota (16km from site) to manufacture ICE vehicles. The assembly of the complete range of Mahindra single- and double cab pick-ups are currently in production within Dube Tradeport SEZ[105]. The established SKDs, automotive suppliers and green development boasts for Dube Tradeport SEZ to be a point of investment.

Dube Tradeport SEZ is home to various environmental management projects that are proactively applying a sustainable approach to business to ensure adherence to environmental sensitivities and to prevent ecological degradation. There projects include:

- Renewable Energy
  Currently, some 24.4% of energy used in Dube AgriZone greenhouses is obtained through renewable sources.
- Solar Power
  Dube AgriZone's array photovoltaic solar panels currently generate 940kWh annually.
- Water Management
  Dube TradePort Corporation has successfully reduced its dependence on municipal water sources, with Dube AgriZone displaying the greatest improvement. Its water consumption endeavours have resulted in usage being reduced from 514.37kl/day to 229.02kl/day, representing a drop in consumption of some 45%.

[104] Dube Tradeport. Environmental Management Projects. https://www.dubetradeport.co.za/index.php/corporate/environmental-management
[105] Mahindra Brits. Local Assembly Facility. 2024. https://mahindrabrits.co.za/local-vehicle-assembly/

- Rainwater Harvesting
  Rainwater harvesting plays a considerable role in efforts to reduce municipal water consumption and currently Dube TradePort Corporation can store 44.4 million litres of water in its ponds.
- Irrigation
  Further efforts about water use have resulted in about 80% of the precinct's irrigation needs being fed through rainwater harvesting.

18.5 Tshwane Automotive SEZ (Manufacturing/Assembly and Recycling)[106]

In terms of automotive OEM proximity, the Tshwane Automotive SEZ provides the most optimal location. Being situated close to multiple existing OEMs enables the new facility to be near most of the potential customers.

- Tenants of TASEZ:
  - Ford
  - Feltex Automotive
  - DSV
  - Automould
  - Hesto
  - SODECIA
  - AIH Logistics
  - Thai Summit Group
  - Forvia Faurecia
  - ADT Alliance
- OEMs in Tshwane:
  - BMW
  - UD Trucks
  - Nissan
  - Volkswagen Amarok
  - Ford
  - Tata

To put it into perspective; once OEMs such as BMW and MBSA start to produce more EVs, if a battery manufacturing and/or assembly facility is close in proximity to their plant (lowering logistical cost) there is an incentive to buy the batteries locally from the new facility and not to import them. Integrating a battery recycling facility within the ecosystem and lifecycle of batteries enables more opportunities. This will mean that OEMs are able to purchase batteries from one facility close to them as well as send batteries to be recycled to another facility close by.

This market penetration is valuable in the TASEZ because of the multitude of OEMs in its vicinity. However, an important note is that since Tshwane is land locked, the logistical cost to import and export remains expensive. This is important to note since various components will still have to be imported specifically regarding battery assembly due certain parts not being available in South Africa. This is also crucial to consider as the costs will remain high when exporting to other countries including the broader Africa.

The TASEZ employs a mixed-energy approach, including gas-to-power and solar photovoltaic (PV) cells with battery storage, to ensure uninterrupted operations within the manufacturing hub and to comply with

[106] TASEZ. Green Energy. 2024. https://www.tasez.co.za/tag/green-energy/

government mandates for green energy solutions. They are currently progressing with a gas-to-power plant project, which will provide 20 MVA, alongside a solar PV and battery storage solution that will contribute an additional 10 MVA.

TASEZ's energy strategy aligns with the United Nations' Sustainable Development Goals, particularly Goal 7, which focuses on providing clean energy; Goal 9, which aims to build resilient infrastructure using innovative technology; and Goal 13, which emphasizes taking action to combat climate change.

19. PROJECT TEAM

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