From Minerals to Manufacturing

Africa's Competitiveness in Global Battery Supply Chains

Final Report – Core Section

October 2024

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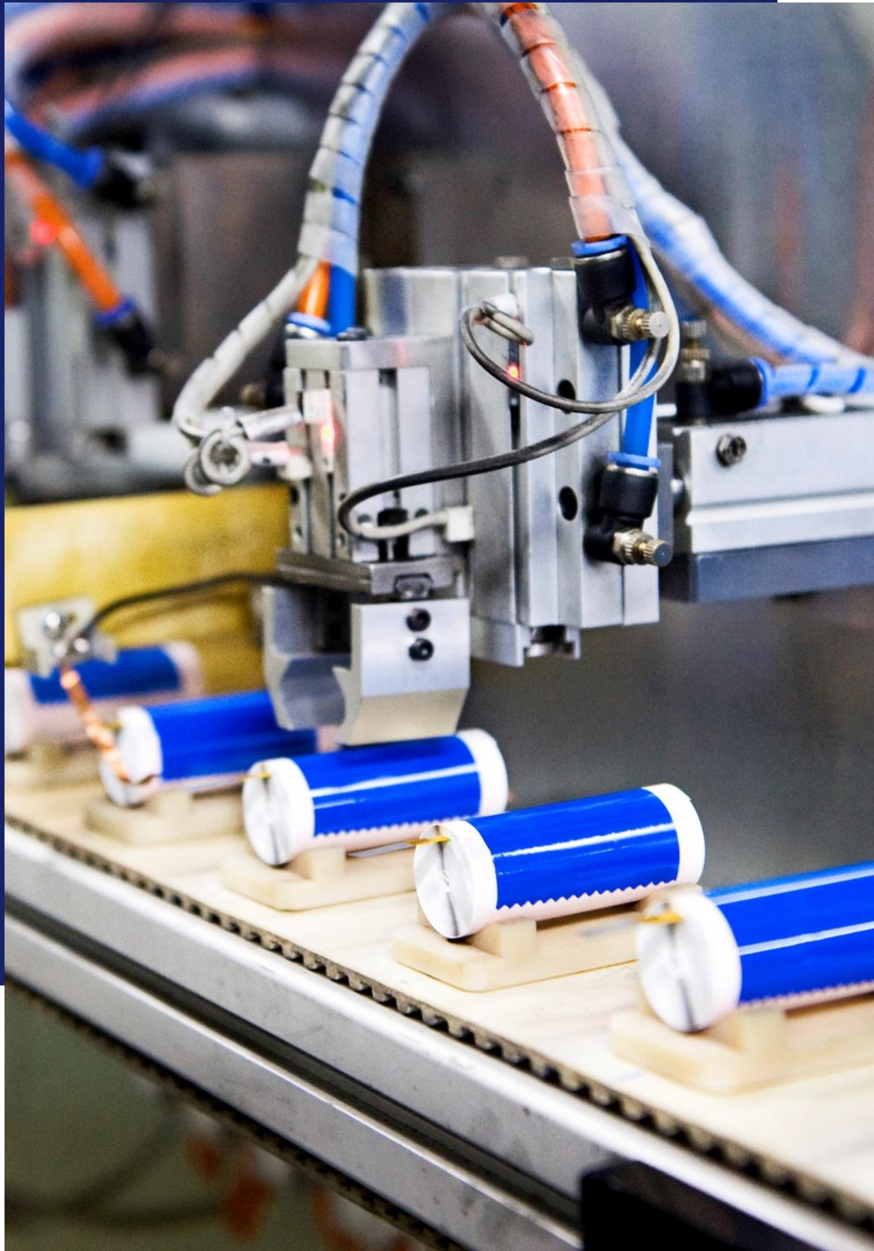

UKaid from the British people | Manufacturing Africa

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THE FARADAY INSTITUTION

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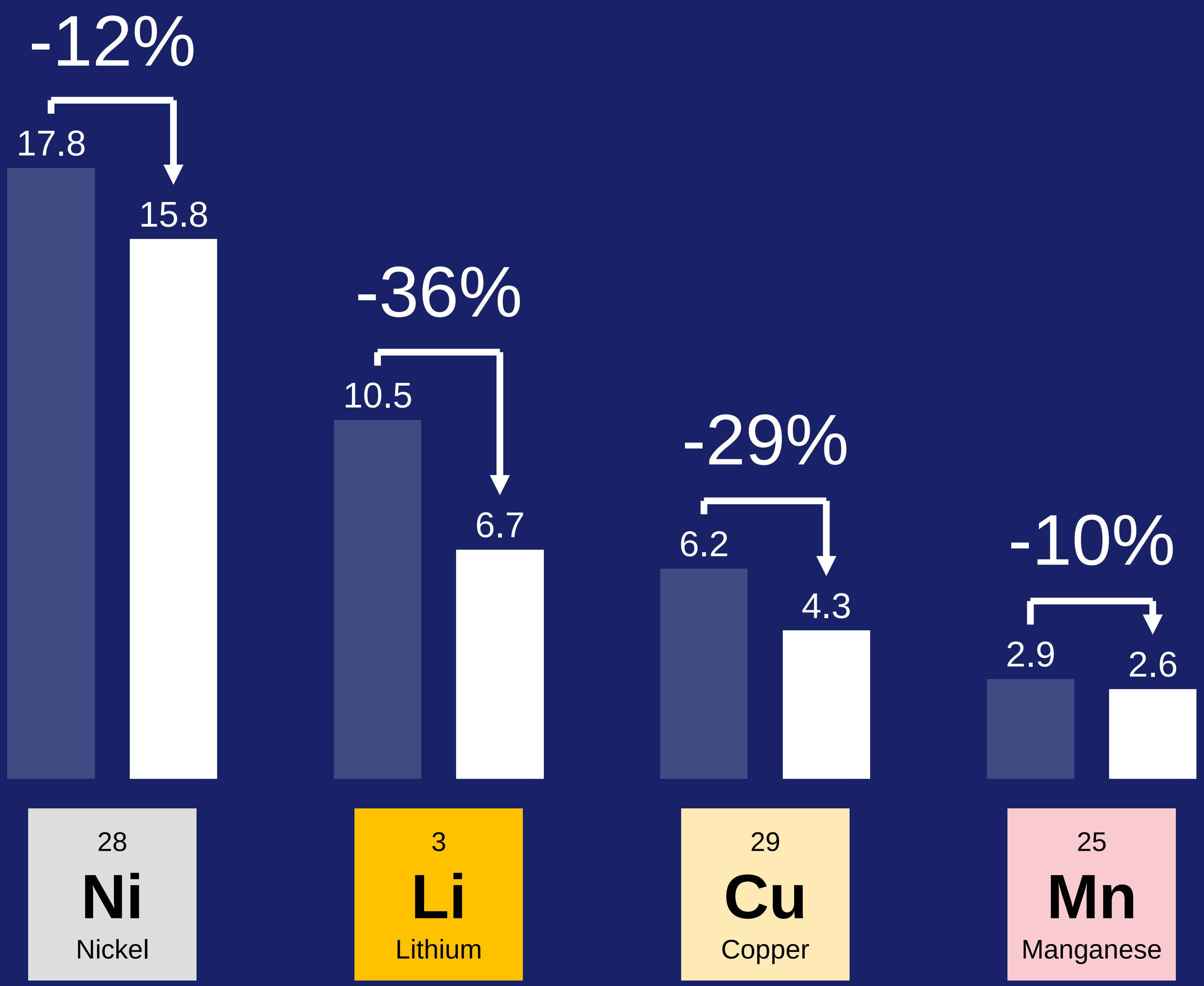
Executive Summary

Weighted average cost for raw materials refining facilities, 2030

USD thousands/tonne

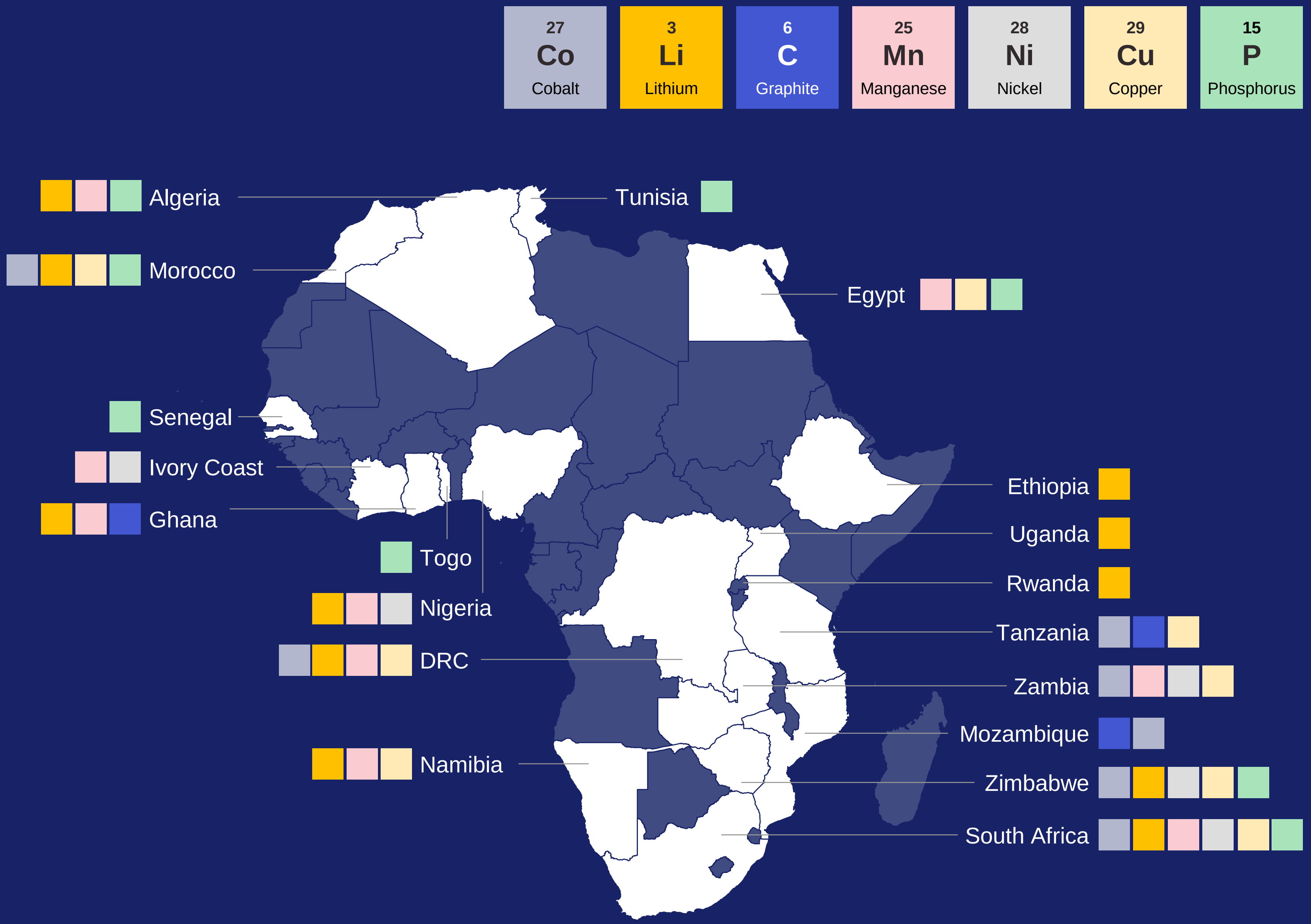
Average

- ▨ Rest of world
- □ Africa



Source: McKinsey MineSpans, Expert interviews

With access to raw materials locally, Africa is well placed to enter battery manufacturing



Source: US Geological Survey (USGS), BCG, AREMI

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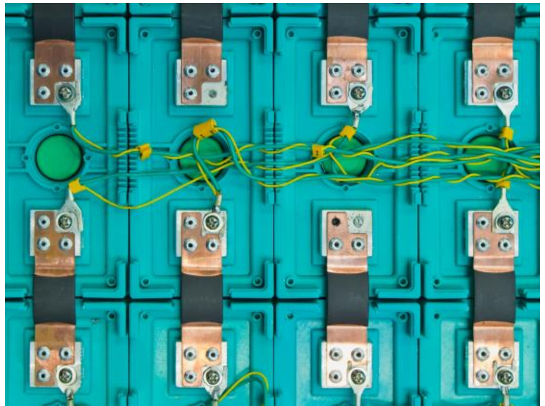
Global & African battery market dynamics

1

Demand

Global battery demand is projected to reach 7.8 TWh by 2035, with China, the US, and Europe representing 80%; Lithium-ion is ~80% of the demand. In Africa, majority of demand will come from electric two/three-wheelers and stationary battery energy storage systems (BESS) with ~3 GWh and ~4GWh of additional annual demand respectively by 2030. The estimated Africa demands is too little for a dedicated Gigafactory (typically at least ~10-15 GWh)



Supply

Regional markets might be strongly unbalanced by 2035, with large oversupply in China and potential undersupply in the US, Europe, and RoW. As the US and the European Union (EU) seek to decrease reliance on China, this creates opportunities in Africa around battery material refining, components and cell production

Key success factors to enter the battery value chain

The battery manufacturing value chain breaks down into 5 main steps

- **Mining/refining**
- **Cell component manufacturing**
- **Cell manufacturing**
- **Assembly**
- **Recycling**

4 overall factors help countries become successful

- **Existence of local comparative advantages**: Countries entering the battery manufacturing value chain typically possess either significant raw materials (e.g., Canada, Indonesia) or large local demand (e.g., China, US); integration along the value chain is a key source of competitiveness
- **Securing economies of scale:** Critical economies of scale and vertical integration are critical for players to be successful in the battery value chain
- **Regionalizing the value chain:** The US, EU, and China have regionalized their supply chains to manufacture locally and reduce costs through economies of scale and lower transport costs.
- **Government support:** Major battery suppliers like China, the US, and the EU have benefited from supportive government policies and initiatives such as the US Inflation Reduction Act (IRA) and the EU Green Deal.

Africa's continental opportunity

2

Opportunities for the African continent

Existence of raw materials: With access to raw materials locally (5 countries having 4 or more key materials locally available), Africa is well placed to enter the battery manufacturing sector

Securing economies of scale: To achieve the necessary 10-15 GWh scale, Africa should target global demand, serving markets like the US and EU which are diversifying away from China. The US IRA favors local production and imports from free trade agreement countries, presenting an opportunity for Africa to supply refined materials. The EU's tariffs on Chinese electric vehicle imports and raw material agreements with African countries indicate a move to reduce reliance on Chinese imports, positioning Africa as a strategic partner.

Regionalizing the value chain: The 2021 Africa Continental Free Trade Agreement (AfCFTA) offers a unique opportunity for African countries to collaborate across the value chain, localizing production and enhancing cost competitiveness.

Government Support: African governments are implementing policies to support the battery value chain. Examples include Kenya's electric vehicle policy, South Africa's electrification policy, and raw material export bans in Namibia, Tanzania, and Zimbabwe.

Opportunities at value chain level

3

Methodology to identify high-potential countries

We narrowed down from 54 Africa countries to 21, through 6 main criteria:

1. Availability of raw minerals
2. Establishment of a manufacturing base
3. Attractiveness to Foreign Direct Investment (FDI)
4. Presence of local battery demand or assembly industry
5. Presence of required talent
6. Existence of trade agreements

Mining/refining

Context	Poor transport infrastructure, lack of skilled workforce, unreliable electricity, high capital expenditure, political instability, and lack of enabling policies are hindering the growth of refining.
Assumptions	A refining plant needs to produce 10,000-15,000 tonnes per year to be cost-competitive globally. The required capital expenditure ranges from USD 0.5-1.5 billion. African countries could refine materials for lithium battery production and export to the US and EU.
Priority countries	Refining could be in countries that are currently mining raw materials required for battery cell production or have a plan to start by 2030. These include: • **Cobalt:** Cameroon, DRC, Ivory Coast, Madagascar, Morocco, South Africa, Tanzania, Zambia, Zimbabwe • **Graphite:** Madagascar • **Lithium:** DRC, Ethiopia, Ghana, Mali, Namibia, South Africa, Zimbabwe • **Nickel:** Cameroon, Ivory Coast, Madagascar, South Africa, Tanzania, Zambia, Zimbabwe • **Copper:** Botswana, DRC, Eritrea, Ivory Coast, Mauritania, Morocco, Namibia, South Africa, Tanzania, Zambia, Zimbabwe • **Manganese:** Botswana, Burkina-Faso, Cameroon, DRC, Egypt, Gabon, Ghana, Ivory Coast, Morocco, Namibia, Nigeria, South Africa, Togo, Zambia • **Phosphate:** Algeria, Angola, Guinea-Bissau, Senegal, South Africa, Uganda

Critical success factors

Secure access to raw materials, low-cost green energy, efficient logistics, large-volume demand through off-take agreements, and government support.

Cost competitiveness

By 2030, African countries can achieve cost competitiveness in refining raw materials, leveraging access to mines, low-cost electricity, and inexpensive labor. African refiners could outperform global counterparts in various materials:

- **Lithium:** 35-40% more competitive, generating ~USD 0.4 billion annually and 100-300 jobs
- **Nickel**: 10-15% cost advantage, generating ~USD 2.3 billion annually and 1,200-1,400 jobs
- **Manganese:** 10-15% lower costs, generating ~USD 0.1 billion annually and 700-900 jobs
- **Copper:** 25-30% more competitive, generating ~USD 4 billion annually and 700-900 jobs

Cell component manufacturing

Context

Battery cell building blocks—cathode, anode, separator, and electrolyte—each have specific active materials. Cathode materials vary by chemistry (LFP vs. NMC), and anodes use natural or synthetic graphite.

Assumptions

Setting up a cathode/anode active materials facility costs ~USD 0.3 billion for 30,000 tonnes/year production. Africa could export cost-competitive products to the US and EU.

Priority countries

Active material production should be in countries mining relevant raw materials by 2030. These include:

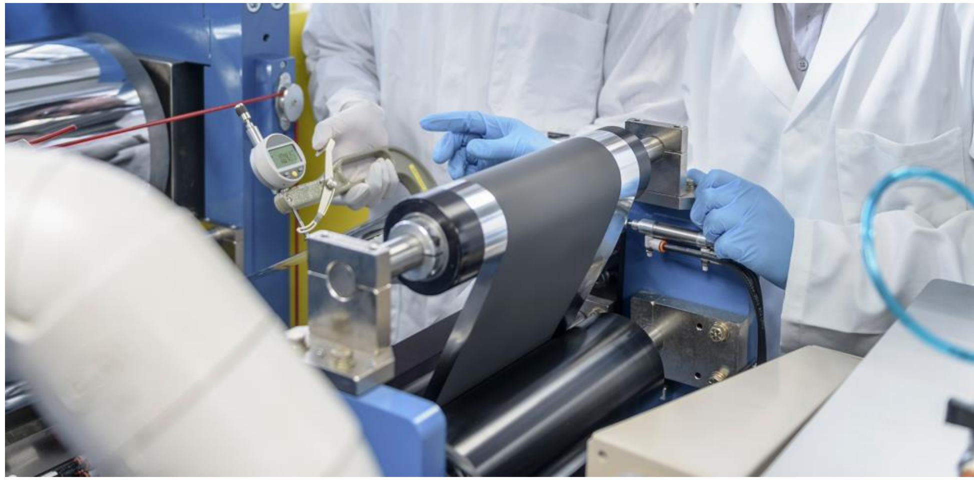
- **Anode:** Botswana, DRC, Eritrea, Guinea, Ivory Coast, Madagascar, Malawi, Mauritania, Mozambique, Morocco, Namibia, South Africa, Tanzania, Uganda, Zambia, Zimbabwe
- **Cathode LFP**: Algeria, Angola, DRC, Egypt, Ethiopia, Ghana, Guinea-Bissau, Mali, Morocco, Namibia, Senegal, South Africa, Tanzania, Togo, Tunisia, Uganda, Zimbabwe
- **Cathode NMC**: Botswana, Burkina Faso, Cameroon, DRC, Egypt, Ethiopia, Gabon, Ghana, Ivory Coast, Madagascar, Mali, Morocco, Namibia, Nigeria, South Africa, Tanzania, Togo, Zambia, Zimbabwe

Critical success factors

Uninterrupted access to refined raw materials and reagents at low cost, low-cost green and reliable energy, proximity to refiners and cell producers, efficient logistics, large-volume demand through off-take agreements, and government support.

Cell manufacturing

Context	Gigafactories are large-scale, high-capex facilities designed for high-volume battery cell production.
Assumptions	A gigafactory requires a capex of ~USD 1 bn to produce 10-15 GWh batteries per year; African countries could produce LFP battery cells and export to the EU market.
Priority countries	Countries that could produce battery cells cost competitively (e.g., Morocco, Tanzania).
Critical success factors	Access to technological and manufacturing IP, low-cost supply chain, efficient logistics, large-scale demand through long-term off-take agreements, willingness to take big bets and government support.
Cost competitiveness	African countries, particularly Tanzania and Morocco, could competitively produce and export LFP batteries to Europe by 2030 at USD 68-72/kWh. This could generate USD 10-15 billion annually and create 22,000-25,000 jobs, rivaling global manufacturers like China, Indonesia, Europe, and the US.
Pre-requisites	For Morocco and Tanzania to emerge as Europe’s preferred LFP providers, certain external factors would need to align, incl.: Europe striving to diminish reliance on Chinese imports, Europe facing a lack of local supply for LFP batteries in 2030, the EU agreeing to refrain from imposing import taxes on African-manufactured batteries, African governments providing subsidies to locally manufactured batteries and African batteries being produced in SEZs with 0% import duties.
Government support	Countries with successful refining industries, like Indonesia, benefited from strong government policies, including export bans, infrastructure investment, skill-building, streamlined regulations, and attractive incentives for investors.



Battery pack assembly for electric two/three-wheelers and BESS

Context	Battery packs can be assembled in African countries by importing cells and components (e.g., BMS, sensors, inverters) and tailoring battery modules to customer needs.
Assumptions	Setting up a battery assembly facility (~USD 2-5 million) to produce ~10 GWh annually could meet internal LFP battery cell demand (~7 GWh by 2030).
Priority countries	Include Egypt, Ethiopia, Ghana, Kenya, Morocco, Nigeria, South Africa, and Tanzania, driven by demand for electric two/three-wheelers and stationary storage.
Critical success factors	Access to low-cost, high-quality components, sufficient local demand, R&D expertise, and export infrastructure.
Cost competitiveness	African countries, particularly Tanzania and Morocco, could competitively produce and export LFP batteries to Europe by 2030 at USD 68-72/kWh. This could generate USD 10-15 billion annually and create 22,000-25,000 jobs, rivaling global manufacturers like China, Indonesia, Europe, and the US.

Recycling

Context	End-of-life batteries can be recycled through repair and reuse, pyrometallurgical recycling, and hydrometallurgical recycling.
Assumptions	Large volumes of batteries are needed for recycling plants to be profitable. Transporting damaged or end-of-life cells is more costly than manufactured cells by ~3-8x. Due to insufficient battery availability and the lack of a Gigafactory in Africa, this step has been deprioritized despite the potential importance of production scrap in recycled materials.
Critical success factors	Access to large amounts of battery waste, efficient logistics, low-cost energy, government regulations, and process expertise.
Way forward	Given the 10-20 year lifespan of typical batteries, African countries implementing electrification policies (e.g., zero emissions generators, BESS) should adopt strategies for battery recycling and disposal to mitigate environmental impacts and access climate finance. Governments and development partners could collaborate to assess/leverage existing technologies from other regions.

Path forward – from projects to impact

4

Historically, Africa has struggled to attract investments and retain local value addition due to political instability, lack of enabling policies, unreliable electricity, poor transport infrastructure, limited skills, and high capital costs.

To successfully implement large-scale battery manufacturing projects and avoid repeating history, **3 key players must be mobilized:**

Local demand stakeholders

Governments and private sector entities with substantial local battery demand should commit to sourcing supplies from African countries to secure demand and de-risk projects.

African governments

Governments with ambitions to develop battery manufacturing sectors must push for enabling policies and reduce bureaucracy to allow industries to develop competitively.

Global financiers

A network of private financiers and Development Finance Institutions (DFIs) could collaborate and use de-risking instruments to secure financing and ensure rapid project implementation.

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- GoKabisa
- Gotion InoBat Batteries
- Hinckley
- Jokosun
- Kifya
- Lepidico
- Manganese Metal Company
- Marula Mining
- Max.NG
- Nevadic
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- Orchard Solutions
- Possible EVs
- Riple
- Sampha
- SEforall
- Shell Foundations
- SINTEF Industry
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- Soliel Power
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Bibliography

Sources of information consulted during the project

Reports

- **Africa Renewable Energy Manufacturing Initiative (AREMI):** Scaling up renewable energy product manufacturing in Africa (December 2022)
- **African Development Bank:** Lithium-cobalt value chain-analysis for mineral-based industrialization in Africa (2021)
- **African Development Bank:** Strengthening Africa's role in the battery and electric vehicle value chain article (2023)
- **BloombergNEF articles**
- **ECDPM:** Green industrialization: Leveraging critical raw materials for an African battery value chain (November 2023)
- **Faraday Institution/Vivid Economics:** Rapid market assessment of energy storage in weak and off-grid contexts of developing countries (October 2019)
- **Faraday Institution:** Battery storage in developing countries (June 2023)
- **GIZ:** Exploration of Market Potentials in Battery Recycling and Refurbishment in Africa (December 2023)
- **International Energy Agency (IEA):** Batteries and secure energy transitions report (2024)
- **Manufacturing Africa:** Rwanda Li-ion battery precursor report (June 2024)
- **McKinsey Insights:** Battery 2030: Resilient, sustainable, circular (January 2023)
- **McKinsey Insights:** Enabling renewable energy with battery energy storage (August 2023)
- **McKinsey Insights:** The battery and cell component opportunity in Europe and North America article (April 2024)
- **SEforAll:** Africa renewable energy manufacturing, opportunity and advancement report (January 2022)
- **SEforAll:** Mission report for Africa-China Business Roundtable in Shanghai, China
- **Shell Foundation:** Exploring the opportunities and impact of sustainable batteries in East Africa (May 2023)
- **UK Government Growth Gateway/BCG:** Africa critical minerals, investment opportunities in midstream processing (January 2024)

Data sources

- Africa Renewable Energy Manufacturing Initiative (AREMI)
- Africa Solar Industry Association (AFSIA)
- Enerdata
- EU CRM Act 2023
- European Union
- FIA Foundation
- Global Data
- International Energy Agency (IEA)
- International Trade Administration
- IRENA
- McKinsey Battery Insights
- McKinsey Centre for Future Mobility
- McKinsey Energy Storage Insights
- McKinsey MineSpans
- Organization of Petroleum Exporting Countries (OPEC)
- Our World in Data
- Statista
- UNCTAD
- UNECA
- US Department of Energy
- US Geological survey
- US Inflation Reduction Act
- US Treasury Department
- USAID/Power Africa
- USGS
- USTR
- World Bank Group
- World Steel Association

Global & African battery market dynamics

1

Key messages

Global demand

Demand expected to **grow ~24%** p.a. 2020-35

Expected to reach **~4.9TWh by 2030,** 90% driven by EVs

SSA demand

Total market is small, ~7 GWh in 2030 (~0.1% of global demand)

Energy storage is **~60%** of total demand

Global supply

Supply/demand for Li-ion could be **balanced by 2035**

Discrepancies expected regionally, e.g., oversupply in China, undersupply in the US, Europe and RoW[1]

Value pools

High-value pools are spread all **along the value chain**

Mining and refining and cell production for mobility will have the **largest value pool in 2030**

Market opportunities

EU and US seek to diversify away from China for refined materials and cell components

Opportunity for **other regions to export to EU/US** where undersupply (e.g., cell components)

Manufacturing approach

Countries with **raw material access** (e.g., Indonesia) enter the value chain through **refining**

Countries with **large local demand** (e.g., US/EU) enter the value chain through **cell production**

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[1] Rest of the world

Source: McKinsey Battery Insights

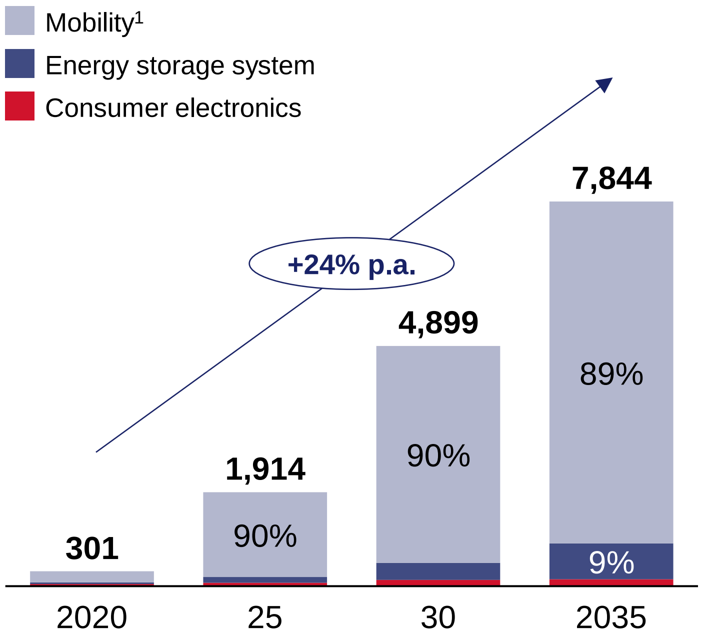
World: Battery demand is projected to reach 7.8 TWh by 2035, with China, the US, and Europe representing 80%; Li-ion is ~80% of the demand

Global demand for Li-ion, Na-ion, 2020-35, GWh

Q2 2024 **CURRENT TRAJECTORY SCENARIO**

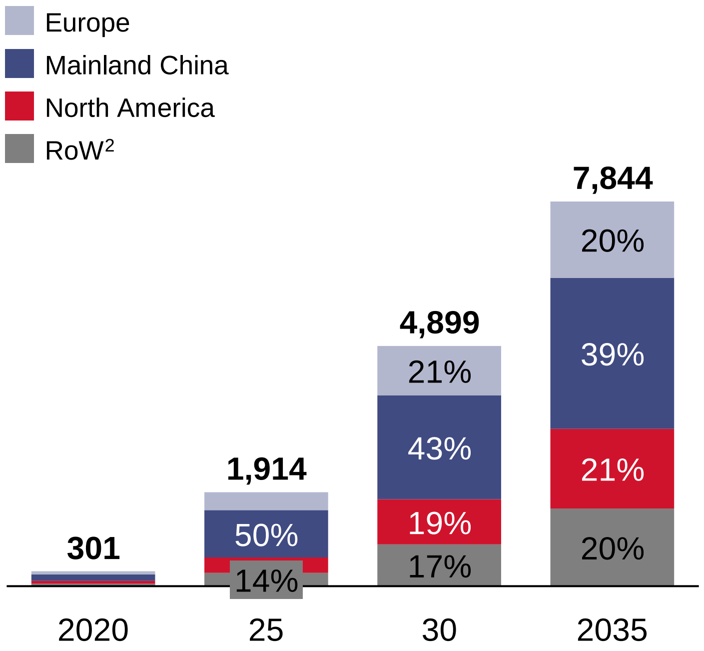
Majority of demand (~90%) will come from EVs…

By sector



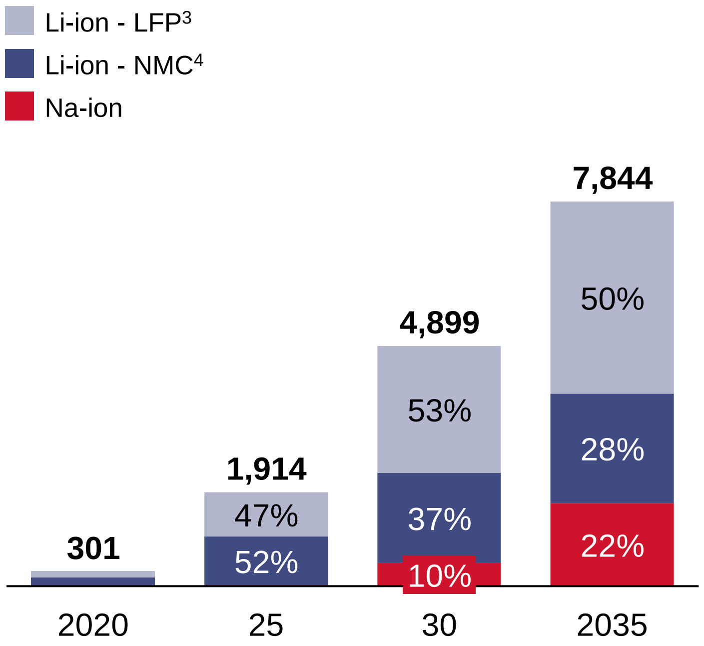
… mainly driven by China, the US, and Europe (80% of demand) and …

By region



Li-ion batteries make up the largest share; demand for Na-ion will pick up in 2030

By technology



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1. Incl. Passenger cars, Commercial vehicles, two/three-wheelers, off-highway vehicles, maritime, drones, and aviation
2. Rest of the world
3. Includes LFP, LCO, LMFP, LMNO, and LMO
4. Includes NCA and NMC (111, 532, 622, 811, 955)

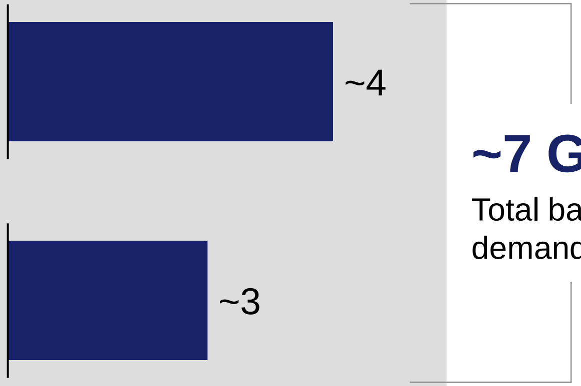
Source: McKinsey Battery Insights Demand Model

Africa's annual demand is expected to represent ~7GWh in 2030, driven by BESS and electric two/three-wheelers

Africa demand for Li-ion

▨ Bottom-up detailed market sizing in annexure (chapter 2)

Main segments of battery demand	Main chemistry	Africa's[1] annual battery demand 2030 GWh
BESS: Demand is expected to grow since fixing Africa's unreliable and insufficient electric grid requires high investment and countries are leveraging renewable energy and BESS to meet electricity demand	Li-ion LFP	~4
Electric two/three-wheelers: Demand is expected to grow since using electric two/three-wheelers reduces cost of transportation significantly and there is a push towards sustainable logistics	Li-ion LFP	~3
Lightweight vehicles and other e-mobility: Demand is expected to be low due to the high initial purchasing cost of an EV, lack of charging ecosystem, and limited customer awareness of the benefits	*N/A*	N/A *Demand expected to be low*



~7 GWh

Total battery demand

Key insights

Africa's demand is expected to be **~7 GWh in 2030, representing only 0.1%** of expected **global demand**

This is **quite low compared to other regions** and to **the scale of traditional gigafactories** (i.e.,the typical size is ~10-15 GWh p.a.)

Demand is expected to be driven by electric two/three-wheelers, cheaper in the long run than ICE counterparts, and **stationary storage (BESS),** required to ensure power in countries with grid instability and off-grid power supply

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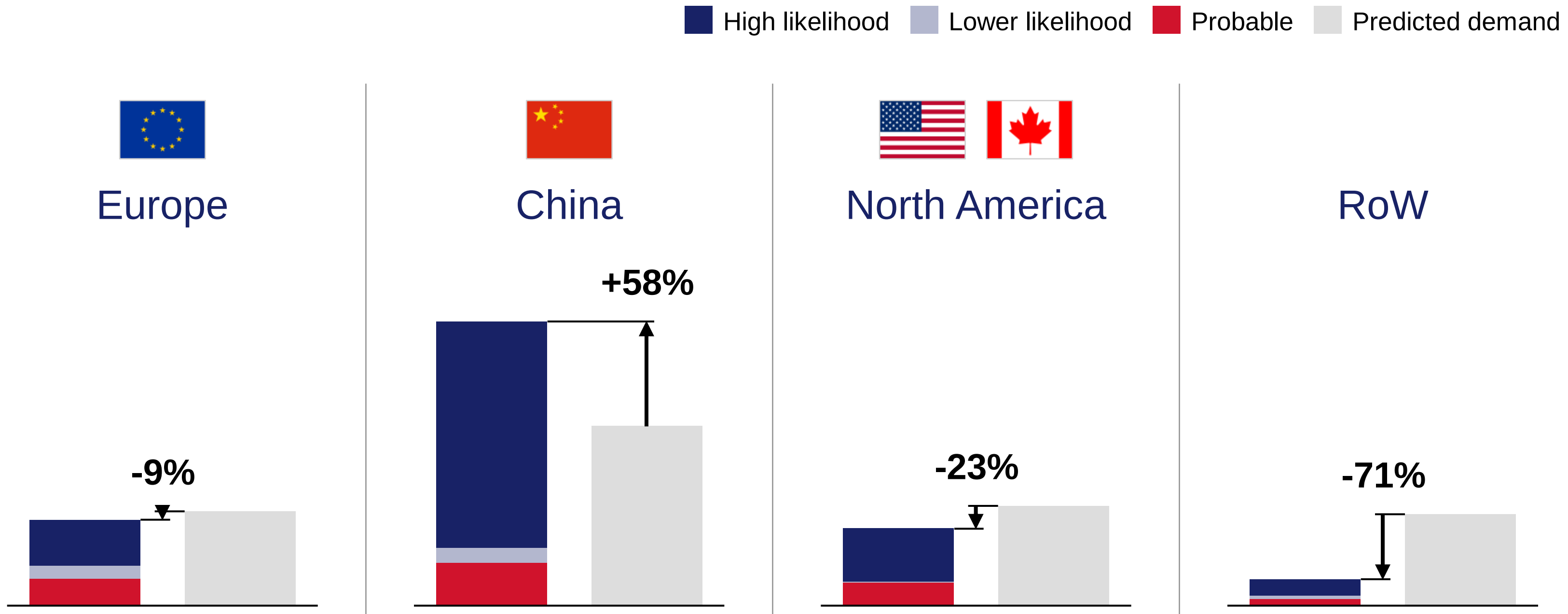
1. **Electric two/three-wheelers:** Countries excluded from the analysis due to unavailability of data (~5% of the African total fleet parc in 2020, ~7% of African population): Cape Verde, Central African Republic, Comoros, DRC, Djibouti, Eritrea, Eswatini, Guinea-Bissau, Liberia, Libya, Mali, Mauritania, São Tomé and Príncipe, Somalia, South Sudan
BESS: Calculated only for 35 African countries (Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, DRC, Egypt, Eswatini, Ethiopia, Gabon, Ghana, Ivory Coast, Kenya, Lesotho, Libya, Malawi, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe)

Source: FIA foundation, Statista, AFSIA, Enerdata, Global Data, USAID/Power Africa/AU-NEPAD, Expert interviews

Regional markets may be strongly unbalanced by 2035, with potential undersupply in the US, Europe, and RoW

Adjusted supply and demand of Li-ion battery cells 2035, GWh

Q2 2024



Potentially balanced demand and supply by 2035, considering there will be few announcements to come and given all projects are realised

Large oversupply (~1.4 TWh in 2035) indicating an **export orientation of industry or low utilisation of assets**

IRA regulation could limit export of battery cells to US post 2025

Potential undersupply by 2035

Concentrated market with a high number of Korean/ Japanese players

Supply mostly coming from Japan and Korea; many announcements from **new players in India** (12 announcements, ~46 GWh estimated production) driven by a local subsidy for cell production

Continued reliance on imports of battery cells

Preliminary insights

Regions with the largest demand are focused on **local production** (US/EU) or have **significant oversupply** (China)

RoW will have a **significant undersupply** with supply ~70% less than demand; **the** market is likely to see **strong competition from China** and new countries entering production (e.g., Saudi Arabia, Qatar)

However, it could be interesting for **African manufacturing** to look at the **needs of the rest of the world,** incl. its **domestic market,** should it benefit from **free trade agreements**

Source: McKinsey Battery Insights battery demand and supply model

There are opportunities around material refining, component, and cell production, as the US and EU seek to decrease reliance on China

		Raw materials		Cell components manufacturing				Cell production		Battery pack		Recycling
		Mining	Refining	Anode	Cathode	Electrolyte	Separator	Mobility	BESS	Mobility	BESS	
Key activities		**Extraction of minerals**	**Refine and process** raw materials into usable products	**Enhance graphite** with additives like silicon, and then coat onto current collector foils	**Convert metal oxides** into a slurry and then coat onto current collector foils	**Mix lithium salt,** such as LiPF6, in an organic solvent	**Leverage dry/wet processes** to convert polyethylene or polypropylene to porous polymer membrane	**Manufacture battery cells** **Stack/roll cells in form factor** (e.g., pouch, cylindrical, prismatic)		**Assemble cells into modules,** modules into packs, and connect hardware and software into complete package		**Reuse batteries** for new purposes (second life) or **recycle components** and materials in batteries
Global value at stake	**Market size 2030 revenue pool**, USD bn	114		19	73	7	14	119	9	73		12
	Structural profitability 2017-21 weighted average EBITDA	15-26%	15-26%	20-25%	10-14%	12-14%	8-13%	9-11%	12-14%	7-13%		6-14%
	Capacity balance outlook, 2030	TBD	Structural supply-demand gap and regionalisation push outside of China	Expected structural undersupply in EU, NA, and RoW						Major increase exp. from automotive industry; opp. for local manufacturing for BESS/two/three-wheelers		Supply addition expected, while relatively limited feedstock is available

Source: Expert calls, McKinsey Battery Insights, AREMI

Africa's continental opportunity

2

4 key factors make countries successful when entering the battery manufacturing value chain

Existence of local comparative advantages (i.e., raw materials or significant demand for batteries)

Ability to achieve economies of scale to ensure cost competitiveness

Ability to regionalise the supply chain to ensure cost competitiveness

Government support to help the development of the ecosystem

Countries that enter the battery manufacturing value chain either have raw materials or large local demand

NON EXHAUSTIVE

Status of integration: 🟦 Integrated 🟥 Not integrated

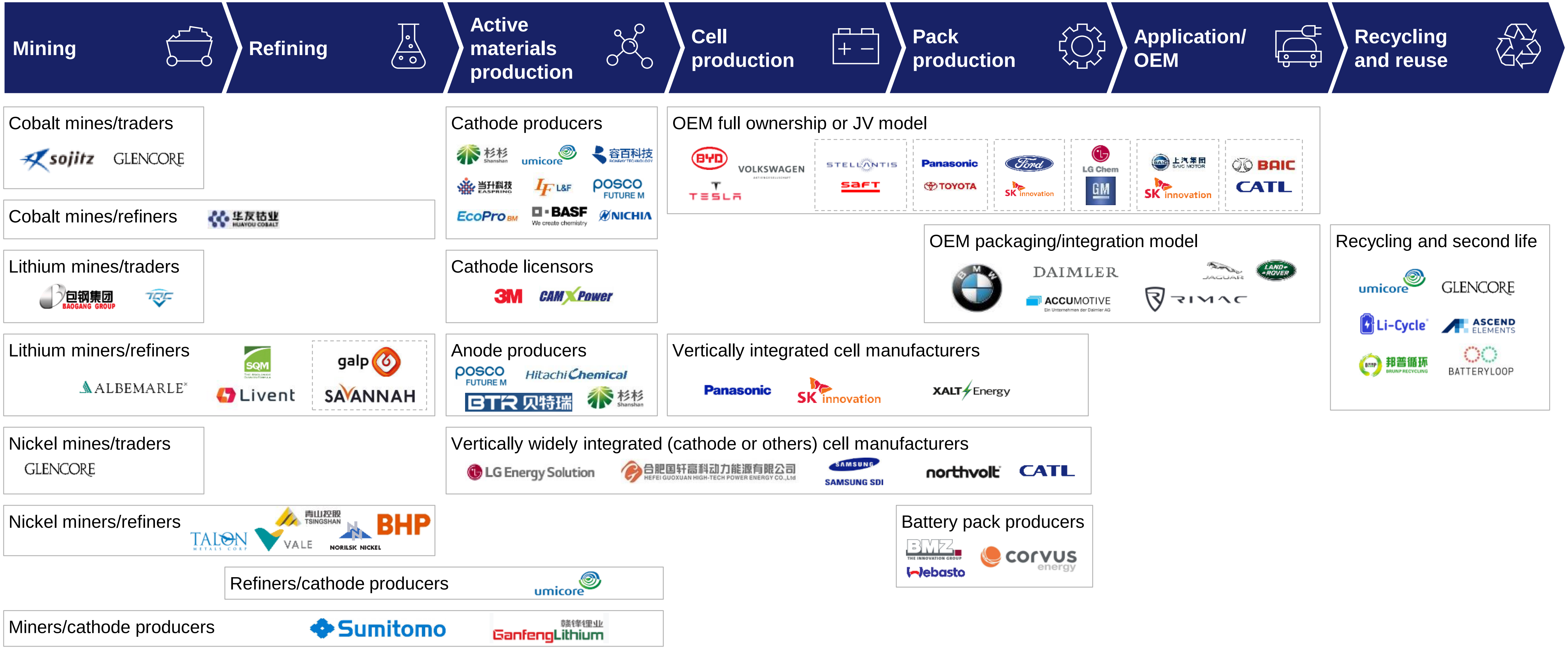
Direction of integration	**Forward** Initial availability of raw material reserves		**Backward** Initial large local demand for batteries	
Example countries	**Indonesia**	**Canada**	**US**	**Germany**
Extent of integration	🟦 Mining 🟦 Refining 🟦 Components 🟦 Cell	🟦 Mining 🟦 Refining 🟦 Components 🟥 Cell	🟦 Mining 🟦 Refining 🟦 Components 🟦 Cell	🟥 Mining 🟦 Refining 🟦 Components 🟦 Cell
Source of competitive advantage	**Largest nickel producer in the world** (projected to produce 50% of global capacity) **Largest labour force in Southeast Asia** (137 mn in workforce) **Sizeable addressable scooter market** that can transition to e-scooters (125 mn scooters in 2022)	**Large reserves of battery metals and available refining capacity** (240,000 tonnes LCE to be mined in 2030) **Access to sizeable OEM market** in the US **Lowest electricity prices in North America** (36% lower than in USA)	**Strong local OEM industry** (7.8% of global EV exports)	**Strong local OEM industry with ambitious EV targets** (~900 000 EVs produced in 2022, second largest producer after China)
Role of government	**Architect of battery ecosystem –** created an SOE that owns stakes in players and regulates relationships between them	**Architect of battery ecosystem –** province created a financing arm that invests in projects via loans or equity	**Market supporter through incentives –** doesn't intervene in market dynamics and only defines incentives (e.g., IRA)	**Market supporter through incentives –** doesn't intervene in market dynamics and only defines incentives

Source: Press search, expert inputs

The battery value chain is facing growing vertical integration, with actors seeking economies of scale

Example of vertical integration along the EV value chain, select players

Q1 2023 **NON-EXHAUSTIVE**



Mining | **Refining** | **Active materials production** | **Cell production** | **Pack production** | **Application/ OEM** | **Recycling and reuse**

Cobalt mines/traders
sojitz GLENCORE

Cobalt mines/refiners
华友钴业 HUAYOU COBALT

Lithium mines/traders
包钢集团 BAOGANG GROUP TQC

Lithium miners/refiners
ALBEMARLE SQM Livent galp SAVANNAH

Nickel mines/traders
GLENCORE

Nickel miners/refiners
TALON VALE 青山控股 TSINGSHAN NORILSK NICKEL BHP

Refiners/cathode producers
umicore

Miners/cathode producers
Sumitomo 赣锋锂业 GanfengLithium

Cathode producers
杉杉 Shanshan umicore 容百科技 当升科技 EASPRING L&F posco FUTURE M EcoPro BM BASF We create chemistry NICHIA

Cathode licensors
3M CAMX Power

Anode producers
posco FUTURE M Hitachi Chemical BTR 贝特瑞 杉杉 Shanshan

OEM full ownership or JV model
BYD VOLKSWAGEN TESLA | STELLANTIS Saft | Panasonic TOYOTA | Ford SK innovation | LG Chem GM | SAIC 上汽集团 SAIC MOTOR SK innovation | BAIC CATL

OEM packaging/integration model
BMW DAIMLER JAGUAR LAND ROVER ACCUMOTIVE RIMAC

Vertically integrated cell manufacturers
Panasonic SK innovation XALT Energy

Vertically widely integrated (cathode or others) cell manufacturers
LG Energy Solution 合肥国轩高科动力能源有限公司 HEFEI GUOXUAN HIGH-TECH POWER ENERGY CO.,Ltd SAMSUNG SDI northvolt CATL

Battery pack producers
BMZ Corvus energy Webasto

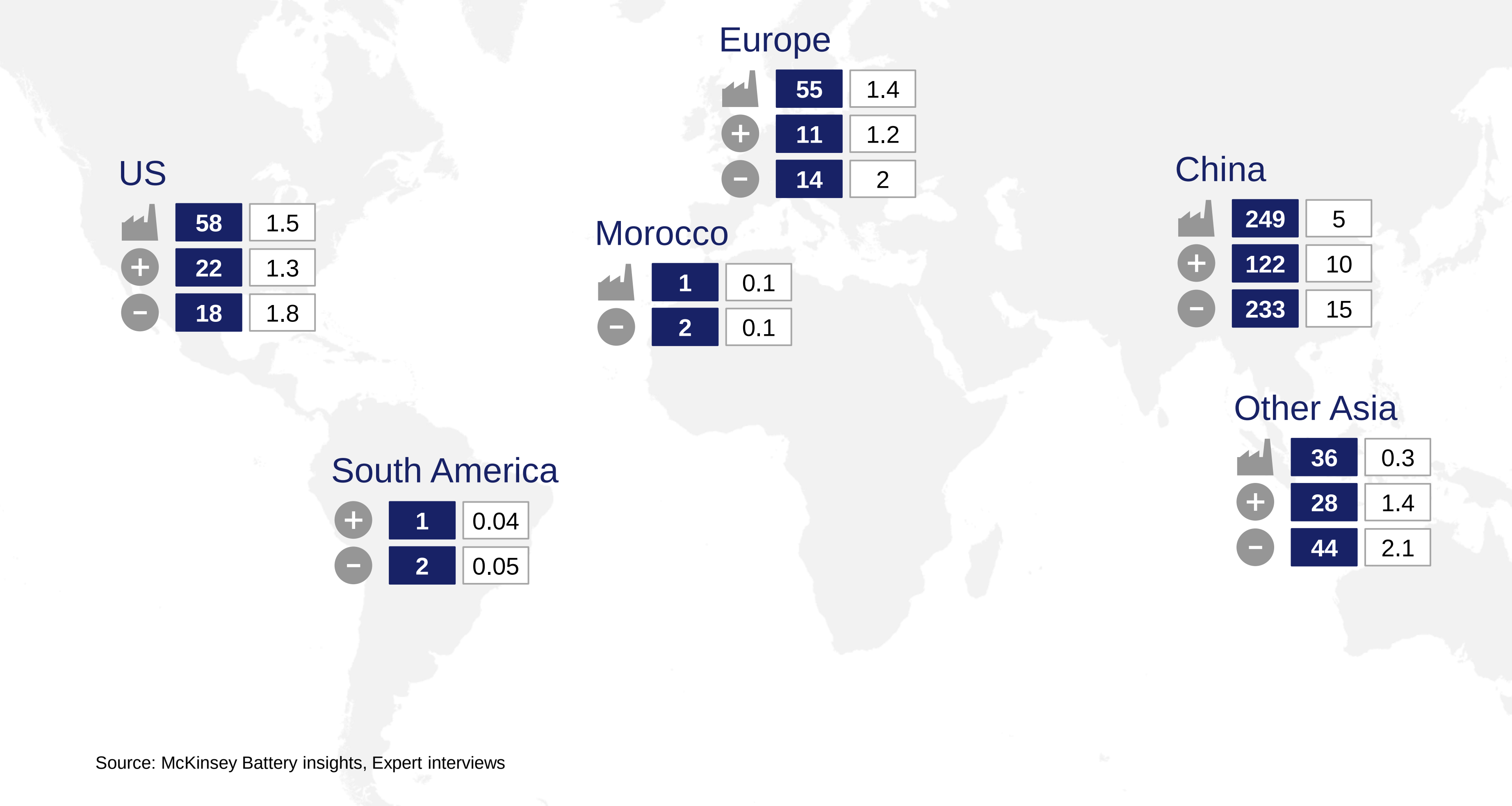
Recycling and second life
umicore GLENCORE Li-Cycle ASCEND ELEMENTS 邦普循环 BRUNP RECYCLING BATTERYLOOP

Source: Press search, McKinsey Battery Insights

The US, EU, and China have strategically regionalised supply chains to reduce costs

World map of expected battery active materials and cell producers in 2030

Gigafactory	■ Number of plants
⊕ Anode plant	□ Yearly capacity, TWh for gigafactory Yearly capacity, mn tonnes for anode/ cathode plants
⊖ Cathode plant	



Europe

Gigafactory	55	1.4
⊕	11	1.2
⊖	14	2

US

Gigafactory	58	1.5
⊕	22	1.3
⊖	18	1.8

Morocco

Gigafactory	1	0.1
⊖	2	0.1

China

Gigafactory	249	5
⊕	122	10
⊖	233	15

Other Asia

Gigafactory	36	0.3
⊕	28	1.4
⊖	44	2.1

South America

⊕	1	0.04
⊖	2	0.05

Source: McKinsey Battery insights, Expert interviews

Key insights

China dominates the supply of batteries and components (anode, cathodes), with ~2-3x more gigafactories and anode/cathode plants than the rest of the world

The US and Europe are focusing on **developing active material plants** near their gigafactories to optimise their **value chains**, minimizing reliance on imports from China and improving **supply chain efficiency** (time and reliability)

Developing gigafactories in African countries requires either establishing a **robust local active materials production market** (capacity currently only present in Morocco for cathode) or importing battery materials from international countries

Government support is integral towards the development of the battery manufacturing industry

Examples of countries and regions that have provided support to help develop industries linked to battery manufacturing

ILLUSTRATIVE **NON EXHAUSTIVE**

	US	Europe	Indonesia
Example of key government measures	**2022 – IRA:** Act aimed at investments in clean energy, healthcare, and tax reforms to stimulate economic growth and sustainability Provides significant subsidies to OEMs under specific conditions (e.g., sourcing of materials outside of China, manufacturing of batteries in North America)	**2024 – Critical Raw Materials (CRM) Act***:* Initiative aimed at diversifying supply of strategic raw materials and reducing dependence on any single country (target of <65% from one country), esp. China **2023 – Carbon Border Adjustment Mechanism (CBAM)***:* Policy aimed at lowering carbon emissions by putting a carbon price on imports of certain goods **2019 – European Green Deal***:* Policy initiatives aimed at making Europe carbon-neutral by 2050	**2020 – Provision of state incentives**: Incentives such as tax reduction, tax holidays, and investment allowances granted to investors within the mineral industry **2014 – Ban on mineral exports**: Ban on all ore exports resulting in a drop in nickel export from 60MT to zero **2013 – Development of industrial parks:** Development of Morowali industrial park worth USD 5 bn to provide infrastructure to support large scale processing facilities
Recent notable develop-ments	**2022** – Albemarle and Piedmont **expanded lithium extraction and processing capabilities within the US**, driven by incentives and market conditions created by the IRA to secure more robust supply chains for EV production	**2023 –** Finish mining company Keliber **received EU backing** to **develop lithium mining and processing capabilities** in Finland through funding from the European Investment Bank, which provides loans and financial instruments to projects that support the EU's policy objectives	**2023 – HLI Green Power** was established as a JV between Hyundai Motor Group and LG Energy Solution to establish a **USD 1.1 bn 10 GWh** battery manufacturing plant

Key insights

Government plays a vital role in the development of the industry **through policies and investments** evidenced in the following countries

US: IRA subsidies incentivising local production have encouraged global players' investments in the battery value chain

Europe: Recent policies (incl. EU Green Deal) and associated incentives have brought battery manufacturers to invest locally

Indonesia: Long-term government policies have enabled to successfully attract battery manufacturers

Source: Press search, Expert interviews

4 key factors would make Africa attractive for the battery manufacturing value chain

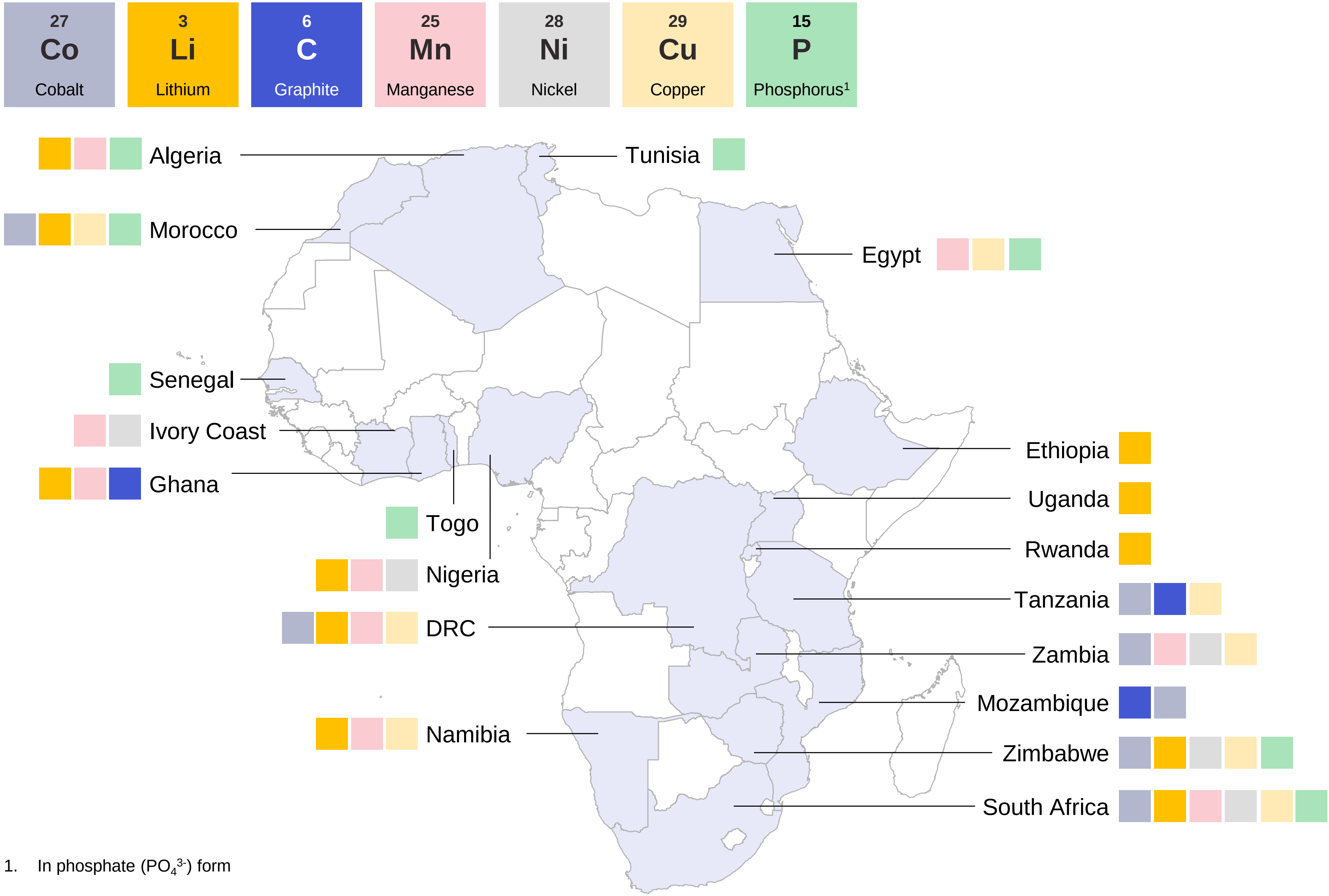
Existence of local comparative advantages (i.e., raw materials or significant demand for batteries)

Ability to achieve economies of scale to ensure cost competitiveness

Ability to regionalise the supply chain to ensure cost competitiveness

Government support to help the development of the ecosystem

With access to raw materials locally, Africa is well placed to enter battery manufacturing



Key insights

Africa is well positioned to enter the battery value chain as it hosts **vast resources of raw materials** critical for battery cell manufacturing (e.g., DRC has 48% global cobalt reserves and 72% production; South Africa has 38% global manganese reserves and 35% production)

5 countries have 4 or more of the key battery raw materials available

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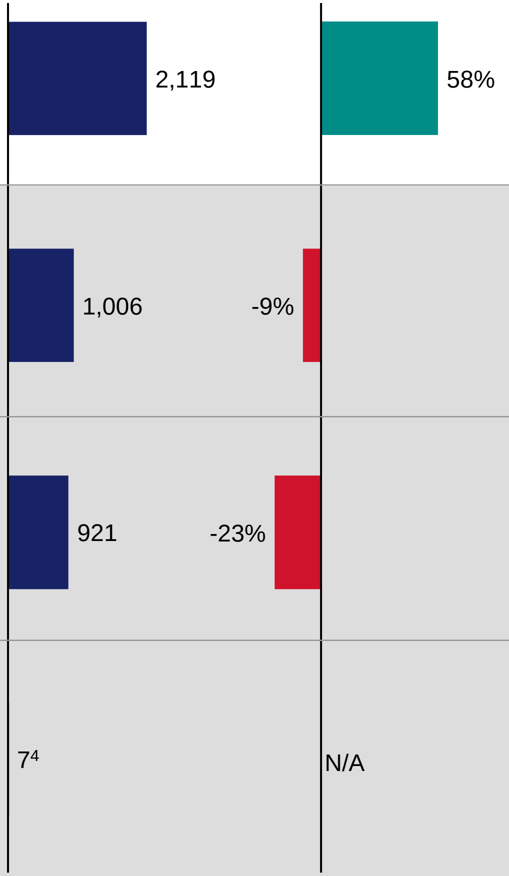
1. In phosphate (PO_4^{3-}) form

Source: US Geological Survey (USGS), BCG, AREMI

To achieve the ~10-15 GWh scale required, Africa could target global demand and seek to serve the US and EU

▨ Most promising markets



Regions/ countries	**Expected demand, 2030,** GWh	**Supply balance, 2035,** %	**Current policy direction**	**Opportunity for Africa**
China	2,119	58%	China has **low production costs** in China as a result of large economies of scale with a **focus on global supply**	China's current oversupply and low production costs makes imports of batteries and materials from Africa or any other region highly unlikely
EU	1,006	-9%	The EU, through the CRM[1] Act (2024), has **encouraged diversification of supply, and local production of batteries** in line with the Green Deal[2] and CBAM[3], 2023 Countries with trade and strategic agreements can leverage these policies to import batteries and battery materials to the EU	**Opportunity to export all materials in the value chain to the EU** as the region seeks to diversify supply away from a single country Existing trade and strategic agreements with African countries (e.g., Everything But Arms) place Africa at an advantage for imports of all value chain parts to the EU
US	921	-23%	The US has moved to **diversify the manufacturing and supply of EVs and EV components away from China**. With the IRA subsidy program, domestic production in North America and imports from FTA countries are encouraged, with a target of 100% local production by 2029 to be IRA eligible	**Opportunity to export refined critical materials to the US** by positioning as an alternative to China While only Morocco has an FTA with the US, other African countries have trade agreements that can be leveraged to export to the US
Africa	7[4]	N/A	There is **no coordinated regional effort** towards the value chain development in Africa. However, several governments have begun to establish specific policies to support the growth of local manufacturing (e.g., Zimbabwe's ban on raw lithium exports) and consumption (e.g., Kenya's EV policy)	**Several private sector players have already shown interest in investing in Africa** to develop local supply chains for batteries (e.g., Gotion in Morocco and Nigeria)

Key insights

To achieve economies of scale, **Africa must focus on meeting global demand for battery materials and components**

The **EU and US are prime markets** due to an anticipated undersupply and their desire to reduce reliance on China. With existing trade partnerships, **Africa can leverage the diversification of supply of these regions**

Africa could also meet some of its own demand through local manufacturing, but this **requires remaining cost competitive with Chinese imports.** Achieving this would allow African manufacturers to meet local demand and participate in the global market effectively

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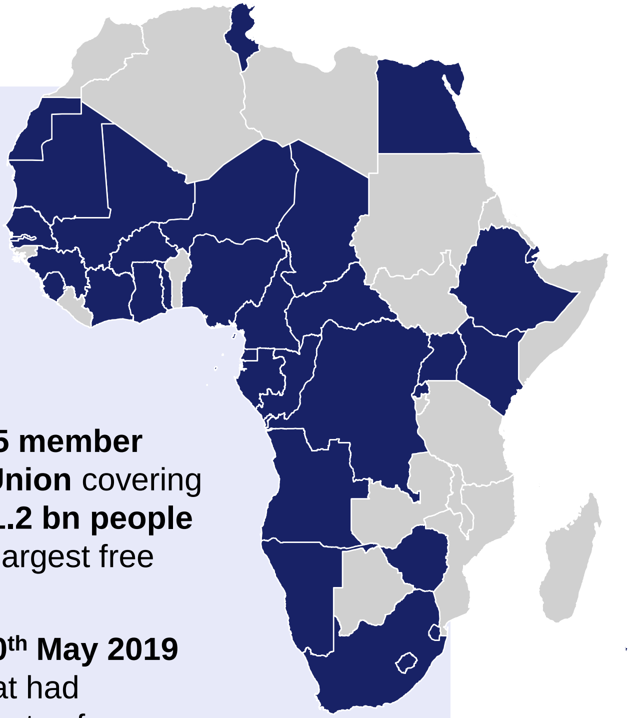
1. Critical Raw Materials act for the diversification of supply of strategic raw materials, 2. A set of policies aimed at making Europe climate neutral by 2050, 3. Carbon Border Adjustment Mechanism to put a carbon price on imports of certain goods and encourage local manufacturing

Source: Press search, McKinsey Battery Insights

The newly signed AfCFTA[1] could bring together the 55 AU member states and enable the regionalisation of supply chains



Description

Bringing **together all 55 member states of the African Union** covering a market of more than **1.2 bn people** potentially creating the largest free trade area in the world

Entered into force on **30th May 2019** for the **24 countries** that had deposited their instruments of ratification

47 countries have both signed and **ratified** the AfCFTA

Agreement was commenced on 1st January 2021

Objectives	→ Potential implications
Create a **single continental market** for **goods and services**, with **free movement** of businesses, people and investments	**Increased talent pool and expertise:** Access to talent from all over the continent with the free movement of people
Enhance the competitiveness of the economies of state parties **within the continent and the global market**	**Increased purchasing power of individuals:** Estimated real income gain of 7% by the implementation of AfCFTA by 2035 – acceleration of middle-class growth as people enjoy wider access to jobs
Promote industrial development through **diversification** and **regional value chain development**	**Wider market access:** Estimated intercontinental export growth by 81% as manufacturers are able to access a larger market and enjoy economies of scale
Accelerate the **establishment of the Continental Customs Union**	**Reduced registration costs:** Potential reduction of tariffs by 90% could increase competitiveness of locally manufactured products with foreign imports
Harmonise and coordinate trade **liberalisation and facilitation** and instruments across the RECs	**Less regulatory burdens:** Potential harmonisation of regulations could eliminate long bureaucratic registration processes simplifying the selling of locally manufactured goods to neighbouring countries

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1. African Continental Free Trade Agreement

Source: World Bank

Several African governments have already started to develop battery-specific policies

Select examples of African countries putting forth battery-specific legislation

ILLUSTRATIVE **NON EXHAUSTIVE**

Select countries	Policies securing demand		Policies encouraging value chain investments		
	Kenya	**South Africa**	**Namibia**	**Tanzania**	**Zimbabwe**
Example of key government measures	**2024: Promotion of local manufacturing and assembly of EVs and their components** through the e-mobility Vehicle Policy	**2013: Incentivisation of local manufacturing** of EVs and its components (incl. batteries)	**2023: Ban on exports of raw lithium,** requiring concentrates to be refined into ores before being exported	**2024: Ban on exports of raw lithium,** requiring concentrates to be refined into ores before being exported	**2022: First African country to announce a ban on exports of raw lithium**, requiring concentrates to be refined into ores before being exported
Recent notable developments	**Launch of multiple strategic partner-ships for local EV manufacturing** • ARC Ride and Watu credit partnership to launch battery swap in Nairobi • Roam secured USD 24 mn to expand production of locally manufactured electric two/three-wheelers and buses	**Development of Li-ion gigafactory:** local energy company, Afrivolt, set to produce batteries and battery cells for stationary storage applications and EVs	**Development of local refining capabilities:** Andrada mining has begun local beneficiation of lithium, indicating a shift towards in-country processing	*N/A, policy too recent*	**Development of local processing: Tsingshan Holding Group to establish lithium mining and processing operations in the country**

Key insights

African countries have established policies that directly impact the battery manufacturing value chain. These countries can be placed into two categories

- **Policies to encourage value chain investments:** Policies such as export bans to encourage local refining encourage investments in the local value chain (e.g., Namibia, Tanzania, Zimbabwe export ban on raw lithium)
- **Policies to secure local demand:** Renewable energy policies poised to secure local battery demand (e.g., Kenya and South Africa renewable energy policies)

These **policies have encouraged investments into different steps of the local manufacturing value chain**

Source: Press search

There is notable development across the battery manufacturing value chain in Africa, with accompanying investments, esp. from Chinese manufacturers

NON EXHAUSTIVE

■ Ongoing activities   □ Planned activities   ⬚ Prospective activities   ● Active Chinese investments

	R&D	Mining	Refining	Cell components	Cell production	Packaging	Application[1] 2/3W	Application[1] 4W	Application[1] ESS	Recycling
● **Morocco**	■	■	■	□	□	□		□		
South Africa	■	■	■	□	□	□		□	■	
DRC **Zambia**		■	□	⬚	⬚					
Kenya					⬚		■			■
● **Nigeria**		■	□			■	■		■	■
● **Zimbabwe**		■	□							
Mauritius				⬚						
Tanzania	■	■	⬚	⬚					■	
Ghana		□							⬚	
Namibia		■	□							

Key insights

Stable political economy**,** geographical **proximity, duty-free exports** to the EU/US and **raw material** reserves position Morocco as a **hub for battery manufacturing** in Africa; multiple Chinese investments (e.g., Gotion)

High demand for **stationary storage** and desire to develop a **Li-ion** value chain have pushed SA's department of science and innovation to develop R&D and Polarium, Afrivolt and Gobeleq to invest

Large amounts **of raw materials** have encouraged DRC and Zambia to establish **shared special economic zones** for **refining and producing precursors** for batteries, supported by UNECA and Afreximbank

Large **demand for electric two/three-wheelers** sees **start-ups** attracting funding (e.g., USD 24 mn secured by Roam); Kenya is developing a battery-specific policy

Demand for ESS and electric two/three-wheelers pushed Nigeria to enter assembly and packaging; Chinese companies looking to maximize the **high-quality lithium reserves** are starting to invest (e.g., Canmax)

With **Africa's largest lithium reserves,** Zimbabwe is seeking to move up the value chain with investments from Chinese companies (e.g., Huayou)

While it **does not have raw materials,** Mauritius has **duty-free exports to EU** and a **stable investment climate**; it is seeing investments in cell component manufacturing (e.g., next source materials)

Thanks to **graphite availability,** Tanzania is pushing a mechanical shaping study to evaluate spherical graphite production (SGP) leading to **establishment of a battery anode manufacturing facility**

With the discovery of **high-grade lithium,** the Ghana Minerals Income Investment Fund (MIIF) has **taken a ~3% stake** (~USD 5 mn) in UK and Australia listed Atlantic Lithium; long term aim to **become a hub for EV production**

Namibia's **efforts to ban export of raw lithium** concentrates showcase its desire to **encourage local refining**

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1. 2WV= Electric 2 Wheeler Vehicles, 3WV= Electric 3 Wheeler Vehicles, 4WV= Electric 4 Wheeler Vehicles, ESS= Energy Stationary Storage

Source: Press search

Several players in the battery value chain are already present in Africa and could be leveraged to kick-start projects

Select examples of players currently active in Africa

	Pan-Africa *(Presence in multiple countries across different regions)*	North Africa *(Morocco, Ethiopia, Egypt, Madagascar)*	West Africa *(Nigeria, Ghana, Senegal, Ivory Coast)*	Sothern Africa *(South Africa, Zimbabwe, Namibia, DRC, Mozambique)*	East Africa *(Kenya, Rwanda, Uganda, Tanzania, Mauritius, Ethiopia, Zambia)*
Mining and refining		**5+** SRG, Haisum, Managem	**10+** GMC, canmax, Ming Xin Mineral Separation (MXMS)	**40+** Battery Minerals, AVZ, Huayou, Namibia	**8+** Sumitomo Corporation, Ethiopian Mineral Corporation, Lepidico, Celsius, arc minerals
Cell components		**9+** Hailiang, Shinzom, BTR, Haisum, Yahua, Al Mada, CNGR, Huayou, Tinci, Managem		**1+** Hulamin, Yokogawa	
Cell production		**4+** Gotion, BTR, Innovx, Shinzom	**1+** Solance	**3+** afrivolt, EcoGraf, Metair, Polarium	**2+** Next Source, Canto
Packaging		**1+** Gotion		**15+** Blue Nova energy, ZettaJoule	**2+** Soleil Power, Bodawerk
Application 2/3W 4W ESS		**1+** Dolidol	**9+** Sterling, Duplantis, Jokosun, Translight Solar	**15+** afrivolt, i-G3N, Potensa, Davis & Shirtliff, Polarium, Globeleq, mellowvans	**8+** Woda, Kabisa go electric, Davis & Shirtliff, Basigo
Recycling			**2+** enviroserve, Hinckley	**1+** enviroserve	**2+** enviroserve
Investors, e.g., DFIs, international development partners, private investors	**4+** Arise, CrossBoundary Group, E-Mobility				
Government representatives		**1+** Ethiopian Mineral Corporation	**1+** Nigeria Sovereign Investment Authority	**1+** ERG	**1+** Africa Battery Initiative

Source: Expert interviews

Opportunities at value chain level

3

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The Africa battery manufacturing value chain scan points to refining, cell manufacturing, and battery pack assembly as having the most potential

Battery value chain	**Raw materials**		**Cell components manufacturing**				**Cell production**		**Battery pack**		**Recycling**
	Mining	**Refining**	**Anode**	**Cathode**	**Electrolyte**	**Separator**	**Mobility**	**BESS**	**Mobility**	**BESS**	
Market attractiveness	High Opportunity with local and international refiners (e.g., EU/US/China)	High Opportunity with African & international cell component manufacturers	Low Potential with EU/US cell producers looking for local sourcing to de-risk current reliance on China Insufficient local demand for economies of scale at this time				Medium Insufficient local demand for economies of scale Opportunities to export to the EU as they seek to diversify supply away from China		Medium Limited local demand for EVs Potential demand for BESS and two/three-wheelers electric mobility		Limited Lack of local supply of used battery supply and waste collection systems
Features of target countries	**Presence of important reserve and mines** of raw materials	**Presence of mining operations** for relevant raw materials High **occupational safety and health** Reliable and cost competitive **electricity**	**Presence of refineries** of relevant raw materials **Cost competitive to compete in the global value chain** or have sufficient local demand		**Presence or proximity** to materials (incl. refined lithium)	**Presence or proximity** to refined oil products	**Proximity to OEMs** Availability of **skilled staff** **EPCs with expertise** in specialised rooms	**High renewable energy** share in electricity mix Availability of **skilled staff** **EPCs with expertise** in li-ion rooms	**Proximity to end market** **Cost** competitiveness Competencies in **software and hardware integration**		**Access to feedstock of second-life batteries**

Important for Africa

Source: Expert calls, McKinsey Battery Insights, AREMI

We identified 6 main criteria that would help us focus our analysis on a medium list of countries

● High ○ Low

Criteria	Rationale for inclusion	Indicators	Weight in overall score
Availability of raw minerals	There is a strategic advantage for players who vertically integrate along the value chain, incl. from mining to refining	Availability of one or more of the following: graphite, nickel, manganese, cobalt, phosphate, lithium, and copper (yes/no)	●
Establishment of manufacturing base	A pre-existing manufacturing base would make the country more attractive to investors; this indicator could also be a proxy for skilled labour availability in the sector	Manufacturing value add (% of country GDP) Total manufacturing value-add (USD)	◕
Attractiveness to FDI	High historical energy FDI inflow indicates the country's openness to global business and ability to attract battery investment	FDI CAGR (%) FDI (USD p.a.)	◕
Presence of local battery demand and assembly industry	There is a strategic advantage to vertically integrate upstream for countries with existing battery demand and with an established assembly industry for four-weelers, two/three-wheelers and BESS[1]	Presence of 4-weelers assembly industry (yes/no) Presence of 2-weelers assembly industry (yes/no) Countries part of the Battery Energy Storage Systems (BESS) Consortium[2] (yes/no)	●
Presence of required talent	Countries with existing required talent benefit from reduced human resource costs, as they avoid the cost of importing talent and providing extensive training	Presence of chemistry manufacturing industry (yes/no) Share of population with advanced degree (%)	◕
Existence of trade agreements	Ease of access to the export market for the locally produced battery makes countries suitable for investment	Existence of a trade agreement with the EU and US (including AGOA[3]) (Yes/No)	◕

We planned to **analyse countries in detail** to identify their potential at each step of the value chain

Therefore, we chose to **focus on the top 21 countries** with the **highest potential** for steps along the battery manufacturing value chain

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1. Battery energy storage system
2. Launched at COP28, the Battery Energy Storage Systems (BESS) Consortium is an initiative launched to promote the development and deployment of large-scale battery energy storage systems across various countries
3. African Growth and Opportunity Act

We analysed all 54 countries and have a long list of 21 priority countries

- Presence of raw materials
- Established manufacturing base
- Capacity to attract FDI
- In-country demand for batteries
- Presence of required talent
- Ability to trade

Source: team analysis

Battery manufacturing value chain

Battery value chain	Raw materials		Cell components				Cell production		Battery pack		Recycling
	Mining	Refining	Anode	Cathode	Electrolyte	Separator	Mobility	BESS	Mobility	BESS	
Features of target African countries	**Presence of important reserves and mines** of raw materials	**Presence of mining operations** for relevant raw materials High **occupational safety and health** Reliable and cost competitive **electricity**	**Presence of refineries** of relevant raw materials **Cost competitive to compete in the global value chain** or have sufficient local demand		**Presence or proximity** to materials (incl. refined lithium)	**Presence or proximity** to refined oil products	**Proximity to OEMs** Availability **of skilled staff** **EPCs with expertise** in specialised rooms	**High renewable energy** share in electricity mix Availability **of skilled staff** **EPCs with expertise** in li-ion rooms	**Proximity to end market** **Cost** competitiveness Competencies in **software and hardware integration**		**Access to feedstock of second-life batteries**

Focus of this section

Source: Expert calls, McKinsey Battery Insights, AREMI

We have looked at 4 important themes to assess Africa’s refining opportunities

What are the current challenges with refining?

Assumptions for target projects

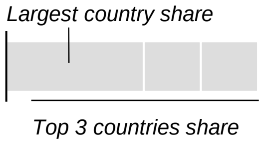
Key success factors

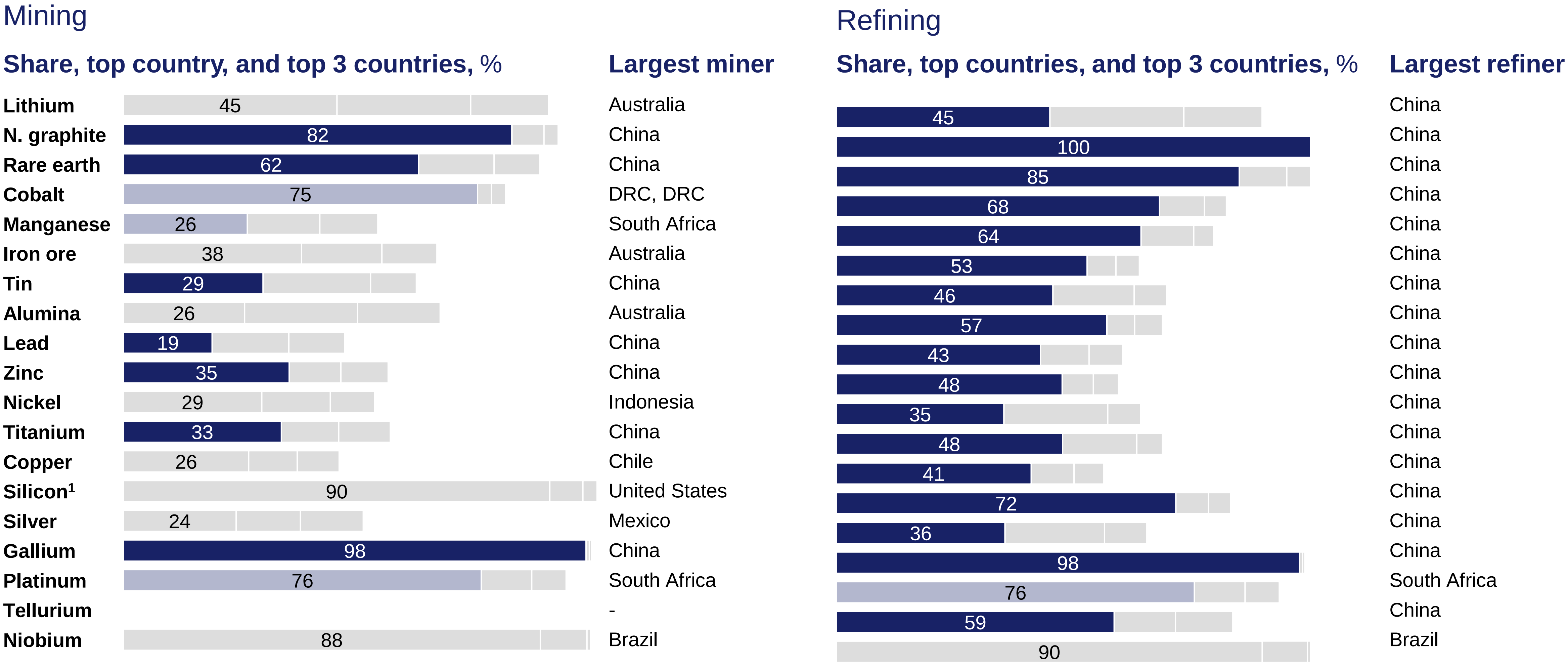
Cost competitiveness

While mining is done in multiple countries, refining of critical raw materials is concentrated in China

Selected commodities, 2021 **ILLUSTRATIVE** **NON-EXHAUSTIVE**

■ China ▨ African country





Mining

Refining

	Share, top country, and top 3 countries, %	Largest miner	Share, top countries, and top 3 countries, %	Largest refiner
Lithium	45	Australia	45	China
N. graphite	82	China	100	China
Rare earth	62	China	85	China
Cobalt	75	DRC, DRC	68	China
Manganese	26	South Africa	64	China
Iron ore	38	Australia	53	China
Tin	29	China	46	China
Alumina	26	Australia	57	China
Lead	19	China	43	China
Zinc	35	China	48	China
Nickel	29	Indonesia	35	China
Titanium	33	China	48	China
Copper	26	Chile	41	China
Silicon[1]	90	United States	72	China
Silver	24	Mexico	36	China
Gallium	98	China	98	China
Platinum	76	South Africa	76	South Africa
Tellurium		-	59	China
Niobium	88	Brazil	90	Brazil

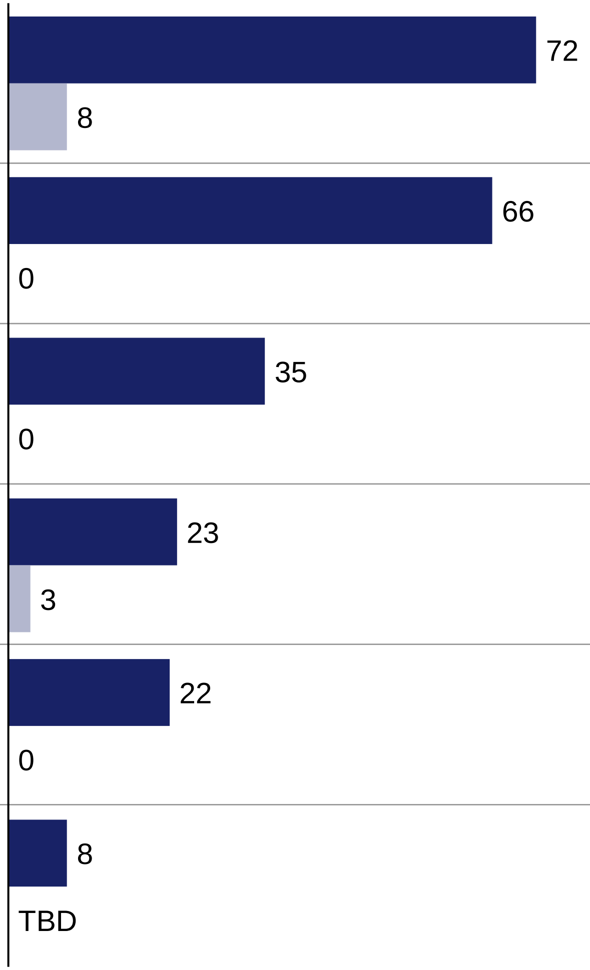
[1] High-purity quartz

Source: McKinsey MineSpans, US Geological Survey, UN Comtrade, World Steel Association, press search

This applies to Africa, where very limited amounts of raw materials are refined on the continent

PRELIMINARY **ILLUSTRATIVE** **NON-EXHAUSTIVE**

■ Share of global production ■ Share of global refining



Raw material	Africa's share of global production and refining in 2023, %	Top African producers	Top export destinations
Cobalt	72 8	DRC (~100% of Africa's production)	China: 72% EU: 4% Other Asia: 4%
Manganese	66 0	South Africa, Gabon, and Ghana (75% of Africa's production)	China: 58% India: 10% EU/Japan/Russia: 12%
Zirconium	35 0	South Africa (~100% of Africa's production)	China: 59% EU: 20% Brazil: 5%
Bauxite	23 3	Guinea (~100% of Africa's production)	*Mostly China*
Graphite	22 0	Mozambique and Madagascar (~100% of Africa's production)	China: 28% EU: 15% Other Asia: 14% US: 7%
Oil	8 TBD	Nigeria, Algeria, Angola, Libya, and Egypt	Tbd

Key insights

There is limited refining in Africa despite having vast resources of raw materials, indicating the existence of significant barriers to refining

For refining to be successful in Africa, it needs to be competitive with China and the EU (Africa's main raw material export destinations)

Source: USGS, IEA, Mining Technology, World Bank, OPEC

We formulated hypotheses to outline key assumptions for successful refining projects in Africa

Key questions	Current hypotheses
What is the ideal plant size to be cost competitive?	To be cost competitive on a global scale (incl. locally compared to imported Chinese batteries), a typical refining plant would need to produce at least **~10,000-15,000 tonnes per year**
What end-market should we target?	As **US** and **EU battery manufacturing companies** seek to diversify away from **Chinese supply** chains, making agreements with them becomes advantageous, as evidenced by recent **EU agreements** to secure **raw materials in Africa**
What is the most demanded battery chemistry?	Globally, Li-ion batteries are expected to be the most demanded by 2035, accounting for **~80% of the global battery cell demand,** with **LFP batteries** (lithium, copper) comprising about **~50%** and **NMC batteries** (nickel, manganese, cobalt, copper) comprising **~30%**
Where could the plant be located?	To be cost competitive in 2030, **refineries need to be located** in countries that have or will have **2030 mining active projects** and **operations** • **Cobalt:** Morocco, Zambia, Madagascar, South Africa, Zimbabwe, Ivory Coast, Cameroon, Tanzania, and DRC • **Graphite:** Madagascar • **Lithium:** DRC, Ethiopia, Ghana, Mali, Namibia, South Africa, Zimbabwe • **Nickel:** Tanzania, Cameroon, Ivory Coast, Madagascar, South Africa, Zambia, Zimbabwe • **Copper:** Zambia, Zimbabwe, DRC, Botswana, Ivory Coast, Eritrea, Mauritania, Namibia, South Africa, Tanzania, Morocco • **Manganese:** South Africa, Zambia, Togo, Morocco, Egypt, Botswana, Burkina-Faso, Cameroon, DRC, Ivory Coast, Gabon, Ghana, Namibia, Nigeria • **Phosphate:** South Africa, Algeria, Guinea-Bissau, Angola, Uganda, Senegal
What is the typical size of investment required for a refinery?	Refinery projects could cost **~USD 0.5-1.5 bn**
Will we be cost competitive?	African countries can **achieve competitiveness in refining raw materials** (e.g., production of lithium refined products is expected to be 35-40% cheaper than the rest of the world in 2030) thanks to their **access** to and **integration with mines, low-cost electricity,** and **inexpensive labour**

Source: Expert interviews

We identified 5 main factors required for countries to be cost-competitive in refining

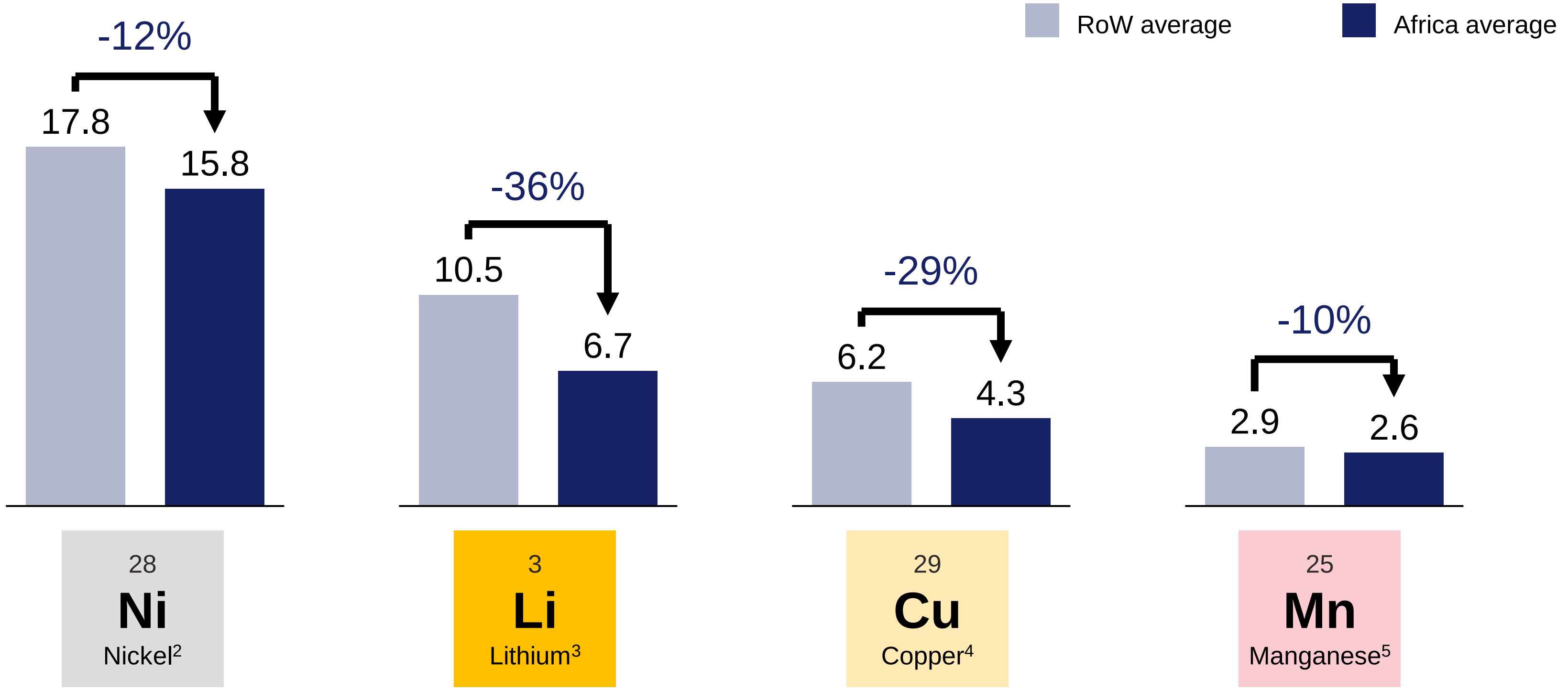
Success factors	Description	Successful example
Secure stable and uninterrupted access to raw materials and consumables at low cost	As raw materials constitute **more than 50%** of the total refining costs, **secure a stable** and **uninterrupted access** to both **raw materials** at low cost (production cost for raw materials), either through **vertical integration** or **strategic partnerships** with **mines**	China, which has become a lead refiner for 90% of the raw materials required in batteries, has made significant investments in Africa to secure access to critical raw materials. In 2020, Molybdenum Co. acquired the Tenke Fungurume Mine in DRC, one of the world's largest sources of cobalt
Access to low-cost, green, and reliable energy along with efficient logistics	As energy costs constitute about **10-15%** of the total refining costs and **clients** (e.g., OEMs in the EU) are prioritising **low-emission refined materials** to achieve their emissions targets, secure access to **large amounts of renewable energy** or **secure affordable financing** to expand their renewable energy production capabilities Possess **adequate infrastructure** for **facilitating imports** and **exports**, incl. roads, railway stations, and port access, or **governments** should commit to making **substantial** and **rapid investments** to achieve these infrastructure levels – *Logistic costs depending on the end market: cost competitiveness analysis to be assessed*	Norsk Hydro's aluminum refining facilities benefit from Norway's abundant hydroelectric power, which provides a low-cost, green, and reliable energy source. Additionally, Norway's advanced logistics infrastructure, incl. ports and shipping routes, ensures efficient transport of refined materials
Confidence in securing large-volume demand in advance through off-take agreements	Secure **large-volume demand** for refined materials with OEMs or active materials producers through **long-term off-take agreements**	US OEMs (e.g., Tesla, GM, Ford, Stellantis) have secured several off-take agreements for refined materials supply with major global companies (e.g., Ganfeng Lithium)
Willingness to take big bets	Demonstrate the willingness to **take big bets** by mobilising **substantial resources** and commitment for large-scale, high-risk projects in the **refining sector**	Aliko Dangote's Dangote Refinery exemplifies the ability to make a big bet, with significant private investment aimed at transforming Nigeria's refining capacity and reducing its dependence on imported refined petroleum products
Government support to clear hurdles to project implementation	Streamline **bureaucratic processes**, enhance **regulatory frameworks**, and provide **targeted financial incentives** to clear any hurdles preventing operationalisation and ensure efficient **project implementation** in the refining sector	The Moroccan government supported Renault by providing specific incentives, establishing a Special Economic Zone (SEZ) in Tangier, building the Tanger Med Port for export purposes, and setting up training schools to ensure a skilled workforce, creating a favourable environment for large-scale operations

Source: Expert interviews, web search

African countries can be competitive in refining raw materials compared to the RoW due to access to mines, cheap electricity, and low labour costs

AS OF JULY 2024

Weighted average cost for raw materials refining facilities, 2030, USD thousands/tonne[1]



Key insights

Nickel: Integration with mines and leveraging high-quality deposits types (laterite vs. sulfide) provide African countries with a competitive advantage by reducing raw material and consumable costs (e.g., reagents for chemical processes)

Lithium: Raw materials costs, comprising more than half of total refining expenses, allow African lithium refiners to gain a competitive edge through raw material integration

Copper: The 2 key differentiating factors for African copper refiners are the high-quality copper deposits in Africa and the integration of raw materials (raw material costs comprising over 90% of total refining expenses)

Manganese: Integrated players in Africa have the potential to compete effectively against non-integrated Chinese producers, due to their cheap labour cost and their raw material integration

1. Depending on the raw materials, different unit of measure: lithium (LCE), nickel and manganese (metal contained), copper (metal refined);
2. Average of the countries considered for the analysis: Africa (Cameroon, Ivory Coast, Madagascar, South Africa, Tanzania, Zambia, Zimbabwe), RoW (China, Indonesia, South Korea, Australia);
3. Average of the countries considered for the analysis: Africa (DRC, Ethiopia, Ghana, Mali, Namibia, South Africa, Zimbabwe), RoW (China, Chile, US, Australia);
4. Average of the countries considered for the analysis: Africa (Botswana, DRC, Ivory Coast, Eritrea, Mauritania, Namibia, South Africa, Zimbabwe, Morocco, Zambia), RoW (China, Chile, US, Japan)
5. Average of the countries considered for the analysis: Africa (Botswana, DRC, Cameroon, Ivory Coast, Burkina Faso, Morocco, Namibia, Egypt, Gabon, Ghana, Nigeria, Togo, Zambia), RoW (China)

Source: McKinsey MineSpans, Expert interviews

For African countries to be competitive in refining raw materials, certain external factors should be aligned

● High ● Low

External factors	Potential pathways to success for African countries	Feasibility[1]
Integration with mines	African refining players should be integrated with mines to secure **direct access to raw materials at production cost**, reducing dependency on **fluctuating market prices** and ensuring **cost efficiency** in production	◐
African governments' commitments to boost local beneficiation	Governments in Africa, following the example of Namibia (i.e., ban exports of unprocessed critical mineral exports), should provide incentives for downstream integration to encourage the development of more **domestic processing**, thereby fostering industrial growth, job creation, and sustainable economic development	◐
Raw materials mines owned by African players	Due to the **high-quality raw materials** in Africa, there is a need for new mines on the continent that are either **not owned by foreign entities** or **do not have long-term off-take agreements** with **foreign entities**	◕
African governments' investments in infrastructures	African governments should continue investing in developing **reliable** and **affordable energy sources** and **infrastructures** to support **mining** and **refining activities**	◕

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1. Assessment based on Expert interviews

Source: Expert interviews

Battery manufacturing value chain

Battery value chain	Raw materials		Cell components				Cell production		Battery pack		Recycling
	Mining	Refining	Anode	Cathode	Electrolyte	Separator	Mobility	BESS	Mobility	BESS	
Features of target African countries	**Presence of important reserves and mines** of raw materials	**Presence of mining operations** for relevant raw materials High **occupational safety and health** Reliable and cost competitive **electricity**	**Presence of refineries** of relevant raw materials **Cost competitive to compete in the global value chain** or have sufficient local demand		**Presence or proximity** to materials (incl. refined lithium)	**Presence or proximity** to refined oil products	**Proximity to OEMs** Availability **of skilled staff** **EPCs with expertise** in specialised rooms	**High renewable energy** share in electricity mix Availability **of skilled staff** **EPCs with expertise** in li-ion rooms	**Proximity to end market** **Cost** competitiveness Competencies in **software and hardware integration**		**Access to feedstock of second-life batteries**

Focus of this section

Source: Expert calls, McKinsey Battery Insights, AREMI

We have looked at 3 important themes to assess Africa's opportunities in battery cell component production

What are battery cell components?

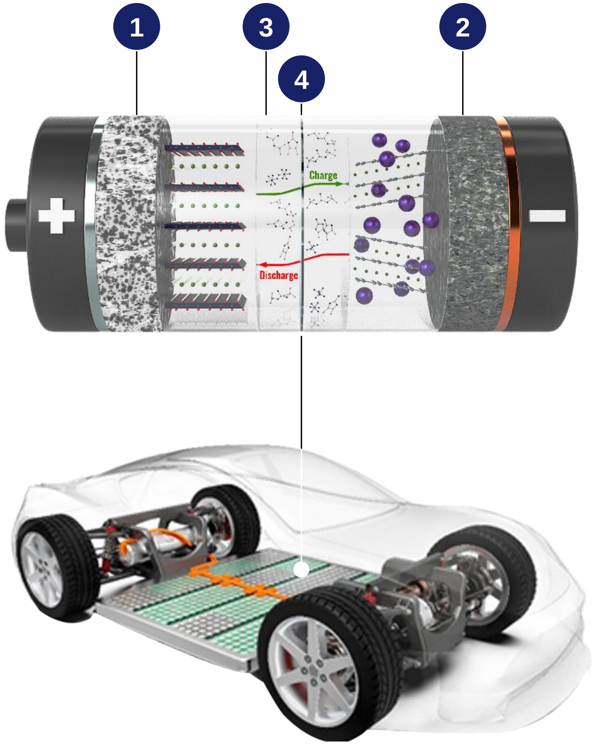
Assumptions for target projects

Key success factors

Battery cells have 4 main components, each with corresponding active materials

▨ Focus of this analysis

Diagram



		Battery chemistry	
Component	Description	Traditional Li-ion	Solid state (SSB)
① **Cathode**	**Lithium transition-metal oxide or phosphate** compound, supported by a current collector providing electrical connection Releases Li-ions and electrons during charging and accepts them during discharging	NMC, NCA/LFP LNMO/LMFP	NMC, NCA/LFP LNMO/LMFP
② **Anode**	**Carbon-based host material** (e.g., natural graphite) supported by current collector, intercalating Li-ions Accepts Li-ions during charging and releases them to cathode during discharge	Graphite/silicon composite	Graphite / silicon composite or Li-metal
③ **Electrolyte**	Made by **dissolving lithium salts in organic solvents** Provides the pathway for ions to travel between anode and cathode	Lithium salt (e.g., $LiPF_6$) in organic solvent (e.g., ethylene carbonate)	Ion conducting solid • Sulphide ceramic • Oxide ceramic • Polymer
④ **Separator**	**Porous electron-insulating material** that is ion-permeable Membrane which prevents anode and cathode from coming into direct contact (preventing short circuit)	Porous polymer (e.g., polyethelyne)	

Source: BNEF, Bernstein, McKinsey

Cathode active materials production varies significantly based on the chemistry type

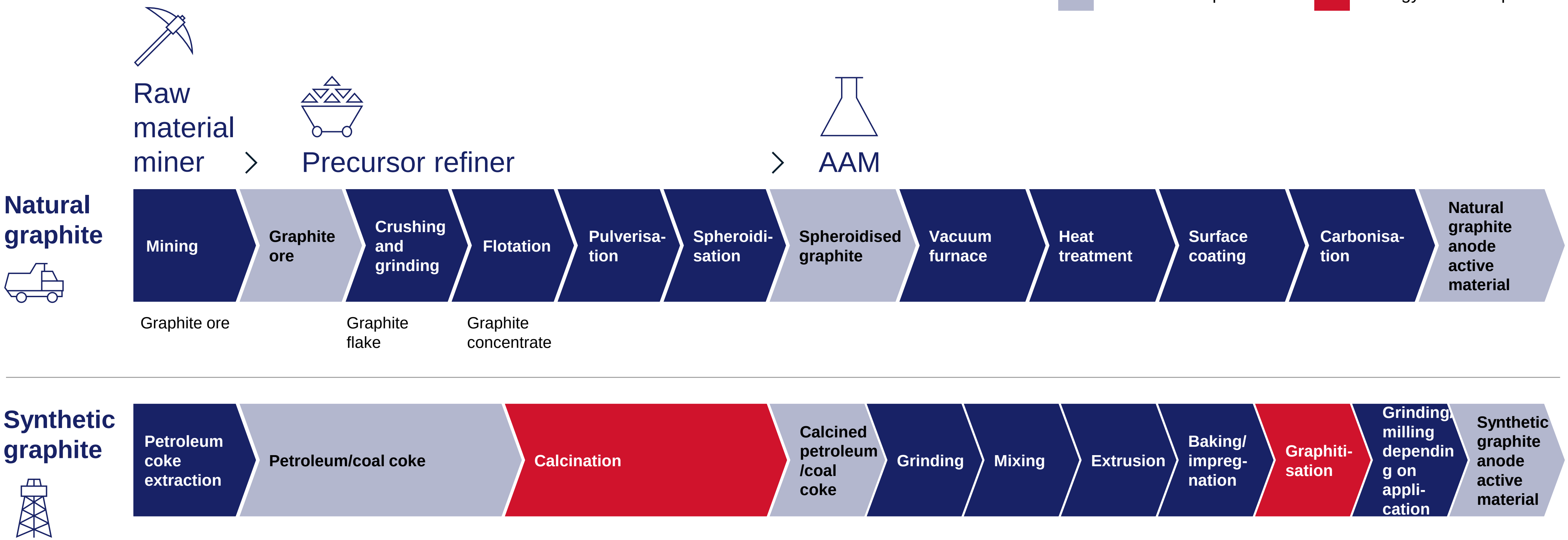
Value chain of cathode active materials

Battery chemistry	pCAM treatment	Material processing	Particle refinement
NMC	Metal salts aqueous solution (e.g., MSO4) and a base (NaOH or Na2CO3), as well as a surfactant (NH4OH), are pumped into a continuously stirred tank reactor (CSTR), in which the metal hydroxide or carbonate precipitates Filter, wash to remove impurities, dry, and sieve Mix with a stoichiometric amount of lithium salt	Mix all the metal oxides with the Li-source in the correct proportions Perform calcination (650-950ºC) Uniformize size through a grinding process	Perform deagglomeration Perform carbon coating surface treatment by adding carbon black
LFP	Dry aqueous solution of LFP oxides, carbon source, and glucose powder material using heated gas Liquid feed is passed through an atomiser that disperses droplets across a heated gas environment	Mix all the metal oxides with the Li-source in the correct Perform calcination (350-1200ºC) Uniformize size through grinding process	N/A
Process similarity	Low	High	Zero

Source: Xuebalib, Literature search

The anode active material value chain varies significantly in terms of feedstock and treatment process depending on the specific type of anode

▨ Intermediate products 🟥 Energy-intensive process



Raw material miner > Precursor refiner > AAM

Natural graphite

Mining > Graphite ore > Crushing and grinding > Flotation > Pulverisation > Spheroidisation > Spheroidised graphite > Vacuum furnace > Heat treatment > Surface coating > Carbonisation > Natural graphite anode active material

Graphite ore

Graphite flake

Graphite concentrate

Synthetic graphite

Petroleum coke extraction > Petroleum/coal coke > Calcination > Calcined petroleum /coal coke > Grinding > Mixing > Extrusion > Baking/ impregnation > Graphitisation > Grinding, milling depending on application > Synthetic graphite anode active material

Source: Industry reports; Expert interviews

We formulated hypotheses to outline key assumptions for successful cathode and anode material production projects in Africa

Key questions	Current hypotheses
What does cathode and anode active material production entail?	• **Cathode (LFP and NMC):** production of cathode powder, primarily oxides of lithium, and other transition metals • **Anode:** production of natural/synthetic graphite from graphite ores or coke
What is the ideal plant size to be cost-competitive?	• 30,000 metric tonnes is required at minimum to become cost competitive (usually, off-take agreements are developed for 10,000 metric tonnes, and it is best practice to serve at least 3 players to reduce risk)
What end market should be the target?	• Export to the US and EU since they are planning to reduce reliance on China and increase the local capacity of battery cell manufacturing

Where could the plant be located?	• Countries with access to low-cost refined/raw materials
	  • **Anode:** South Africa, Morocco, Mozambique, Ghana, Namibia, and Tanzania
	  • **Cathode LFP:** Algeria, Guinea-Bissau, Angola, South Africa, Uganda, Senegal, Zimbabwe, Ethiopia, Ghana, Mali, Namibia, DRC
	  • **Cathode NMC:** Tanzania, Cameroon, Ivory Coast, Madagascar, South Africa, Zambia, Zimbabwe, Gabon, Ghana, Namibia, Nigeria, Togo, Morocco, Egypt, Botswana, Burkina-Faso, DRC, Ethiopia, Mali

What type of battery chemistry should be the target?	• Cathode: LFP and NMC Li-ion batteries are expected to have the greatest demand in 2035 globally, ~80% of the global battery cell demand (LFP ~50% and NMC ~30%) • Anode: Natural graphite since it has lower cost and lower energy consumption
What is the typical investment size required for a CAM[1] and AAM[2] production?	• ~0.3 USD bn (assuming USD 10 mn per 1,000 tonnes)
Will we be cost-competitive?	• Assuming low-cost access to lithium, Africa could be cost competitive in CAM production

1. Cathode active material (CAM)
2. Anode active material

Source: Expert interviews

We identified five main factors required for countries to be cost competitive in cathode and anode active material production

Success factors	Description	Successful example
Uninterrupted access to refined raw materials (Ni, mn, Co, C, Li) and reagents at low cost	• Ensure **consistent, low-cost access to refined materials** by owning a refinery or forming strategic partnerships • **Raw materials constitute ~85%[1] of the total production cost**	🇨🇳 China is a major producer of Li-ion batteries and has streamlined supply chains, enabling efficient component procurement
Access to low-cost green and reliable energy	• Ensure **access to sufficient energy** for the energy-intensive processes • **Renewable energy is preferred** since the EU market is prioritising low-emission refined active materials to achieve their emission targets	🇸🇪 Companies like Northvolt in Sweden benefit from green energy sources, which contribute to the cost-effective production of cathode active materials and battery cells
Proximity to refiners and cell producers and efficient logistics	• **Locate the manufacturing facility close** to where **raw materials** are refined and **battery cells are produced** to reduce logistic and transportation costs • Develop sufficient infrastructure for imports and exports, including road, rail, and port access	🇸🇪 Northvolt has strategically positioned its gigafactories close to raw material suppliers and major European automakers
Confidence in securing large-volume demand in advance through off-take agreements and accelerated time to market	• Secure **large-volume demand** with battery cell producers through **long-term off-take agreements (10,000 metric tonnes off-take agreement with at least 3 players/ customers)** • **The manufacturing facility should be developed in a short time** and there **should be accelerated time to market** since a long development time could lead to outdated facility equipment and multiple players are entering the market	🇯🇵 Japan's Panasonic Corporation, a key supplier to Tesla, has successfully secured long-term agreements with automakers for cathode materials
Government support to clear hurdles to project implementation	• Streamline **bureaucratic processes,** enhance **regulatory frameworks,** and provide **targeted financial incentives** to clear any hurdles preventing operationalisation	🇪🇺 In Europe, the European Battery Alliance and initiatives like the European Battery Innovation project receive government backing to accelerate the development of battery materials

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1. For cathode active material

Source: Expert interviews, web search

Battery manufacturing value chain

	Raw materials		Cell components				Cell production		Battery pack		Recycling
Battery value chain	Mining	Refining	Anode	Cathode	Electrolyte	Separator	Mobility	BESS	Mobility	BESS	
Features of target African countries	**Presence of important reserves and mines** of raw materials	**Presence of mining operations** for relevant raw materials High **occupational safety and health** Reliable and cost competitive **electricity**	**Presence of refineries** of relevant raw materials **Cost competitive to compete in the global value chain** or have sufficient local demand		**Presence or proximity** to materials (incl. refined lithium)	**Presence or proximity** to refined oil products	**Proximity to OEMs** Availability **of skilled staff** **EPCs with expertise** in specialised rooms	**High renewable energy** share in electricity mix Availability **of skilled staff** **EPCs with expertise** in li-ion rooms	**Proximity to end market** **Cost** competitiveness Competencies in **software and hardware integration**		**Access to feedstock of second-life batteries**

Focus of this section

Source: Expert calls, McKinsey Battery Insights, AREMI

We have looked at 3 important themes to assess Africa’s cell manufacturing opportunities

What is a gigafactory?

Assumptions for target projects

Key success factors

Cost competitiveness

A gigafactory is a large-scale manufacturing facility designed for the high-volume production of batteries, crucial for EVs and BESS

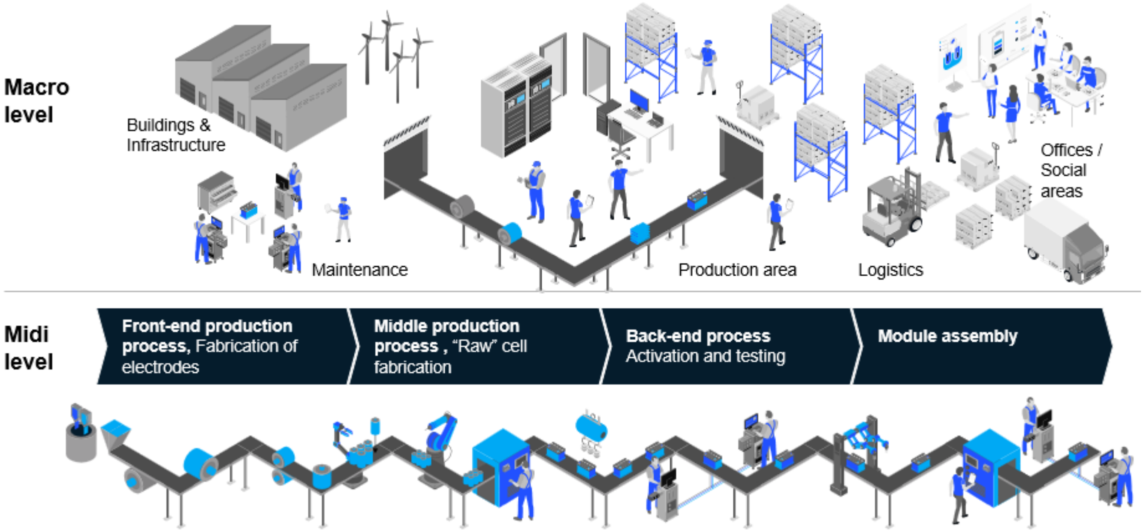
Description

A gigafactory is a **large-scale manufacturing facility** designed to produce **mass quantities of batteries**

Gigafactories **utilise cutting-edge technologies** (e.g., advanced robotics, AI-driven quality control systems, and continuous R&D) and **automation** to enhance **production efficiency,** ensure **high-quality output,** and **reduce costs**

Gigafactories often prioritise **sustainability,** employing **renewable energy sources** like **solar** and **wind** to power operations, aiming to **reduce the carbon footprint** of **battery production**

High-level example of battery gigafactory process



Main challenges for building a gigafactory

Capex: Building a gigafactory involves immense financial investment for construction, equipment, and technology

Skilled labour availability: gigafactories need a highly skilled workforce proficient in advanced manufacturing, robotics, and battery technology

Active and technology material procurement: securing a reliable and sustainable supply chain for active materials and advanced manufacturing technologies

Secure demand: Ensuring consistent and large-volume demand through long-term contracts and partnerships with OEMs

Source: Expert interviews, web search

We formulated hypotheses to outline key assumptions for successful battery cell production projects in Africa

Key questions	Current hypotheses
What is the ideal plant size to be cost competitive?	To be cost competitive on a global scale (incl. locally compared to imported Chinese batteries), a typical plant would have to be **~10-15 GWh**
What end market should we target?	**Total expected 2030 demand in Africa of ~10 GWh from E two/three-wheelers and BESS**, with very small demand expected from EV → Africa would need to target export markets in order to achieve required economies of scale to be cost competitive Considering ongoing trade agreements and **US IRA requirements**, African manufactured batteries could instead target exports to the **EU market**, which has high demand from **EV OEMs** and lacks domestic **LFP production** (~103 GWh demand expected in 2030 from the EU for batteries – SteerCo 1)
What battery chemistry should we focus on?	Most **demand locally** (electric two/three-wheelers, BESS) and **internationally** (EVs from the EU) would target **LFP chemistry, NMC** is typically reserved to high-end EVs and electric two/three-wheelers
Where could the plant be located?	If a plant were to **serve the EU EV market,** it could be **located close to an OEM manufacturing site exporting to the EU,** as EV batteries need to be designed and specific to each car (e.g., Morocco, with its automotive manufacturing industry, is a prime location for manufacturing) or in countries with **developed export infrastructures** (e.g., Tanzania with the port of Dar es Salaam)
Where would we source the required raw materials?	**Only Morocco would produce cathode materials** (i.e., cathode) required for battery manufacturing by **2030**, thus any plant would need to either import from Morocco (only cathodes) or from other **active materials-producing countries** (e.g., China)
What is the typical size of investment required for a gigafactory?	Typical gigafactories cost **~USD 1 bn**
Will we be cost competitive?	African countries could be competitive in **producing** and **exporting LFP batteries to Europe** by **2030** (e.g., USD 72/kWh in Morocco and USD 68/kWh in Tanzania compared to USD 68/kWh in Europe), but **governments** would need to **implement subsidy programmes** to compete effectively with the **rest of the world**

Source: Expert interviews

We identified 4 main factors required for countries to be cost-competitive in battery cell production

Success factors	Potential pathways to be successful for African countries	Successful example
Access to high-quality battery pack components at low cost and efficient procurement	Invest in **R&D** and **strategic partnerships** to **acquire** and **develop** proprietary technologies, collaborate with universities and research institutions to stay at the **forefront of technological advancements,** and secure **patents** and **licences** for key technologies	🇰🇷 LG Energy Solution has built a robust portfolio of battery-related IP through significant investment in R&D and strategic partnerships with leading universities and research institutions
Ensure a low-cost supply chain and efficient logistics	As raw materials constitute about **65-75%** of the total cell cost, **secure a stable** and **uninterrupted access** to **active materials** at low cost or **integrate vertically upstream the value chain** Possess **adequate infrastructure** for **facilitating imports** and **exports**, incl. roads, railway stations, and port access, or **governments** should commit to make **substantial** and **rapid investments** to achieve these infrastructure levels	🇨🇳 CATL has established a highly efficient and low-cost supply chain by building strong relationships with raw material suppliers and investing in local production facilities
Secure large-scale demand though long-term off-take agreement	Negotiate **long-term off-take agreements** with **OEMs** and other major customers to ensure large-scale stable demand	🇰🇷 Samsung SDI has successfully secured large-scale demand for its battery cells through long-term off-take agreements with global automakers such as BMW and Volkswagen
Willingness to take big bets	Demonstrate the ability to **take big bets** by **mobilising substantial resources** and **commitment for large-scale**, **high-risk projects** in cell production	🇩🇪 The German government has supported Volkswagen's large-scale investment in battery cell gigafactories across Europe, showcasing the mobilisation of significant resources to strengthen their EV battery supply chain

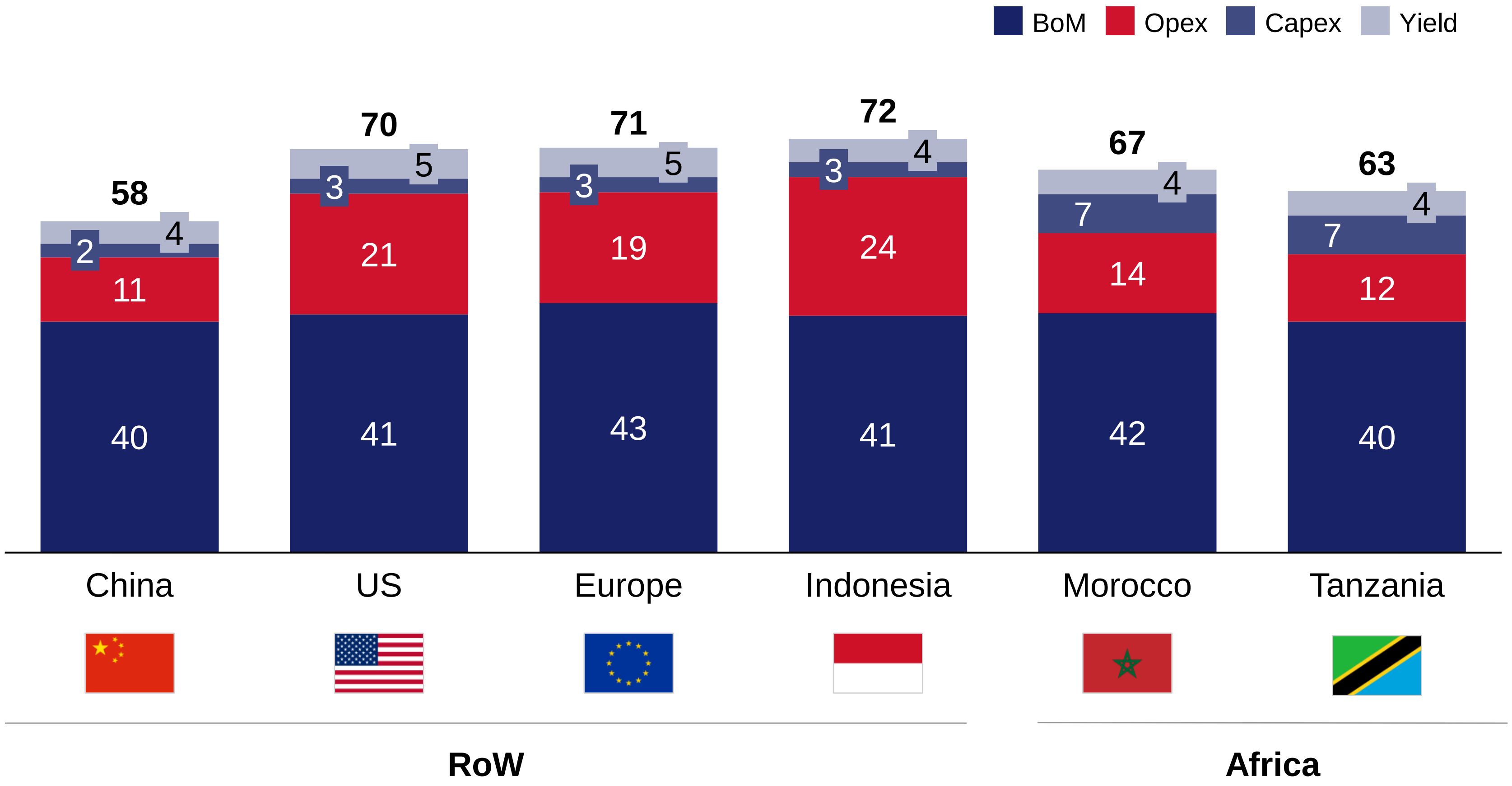
Source: Expert interviews, web search

Despite higher production costs compared to China, Morocco and Tanzania would remain more competitive than the US, Europe, and Indonesia

ANALYSIS NOT INCLUDING LANDED COSTS **AS OF JULY 2024**

EXAMPLE FOR MOROCCO AND TANZANIA, REPRESENTATIVE OF COUNTRIES WHICH COULD POTENTIALLY PRODUCE CELLS

Cell manufacturing average cost breakdown by country, USD/kWh



Source: Battery Insights, Expert interviews

Key insights

Despite **higher production costs** compared to China, **Morocco** and **Tanzania** would remain more competitive than the **US**, **Europe**, and **Indonesia**, primarily due to their ability to:

- Access lower **operational costs** (e.g., cost of labour, cost of electricity)
- **Procure BoM** at competitive rates thanks to **SEZ,** allowing to import materials from China with a **0% import duty**

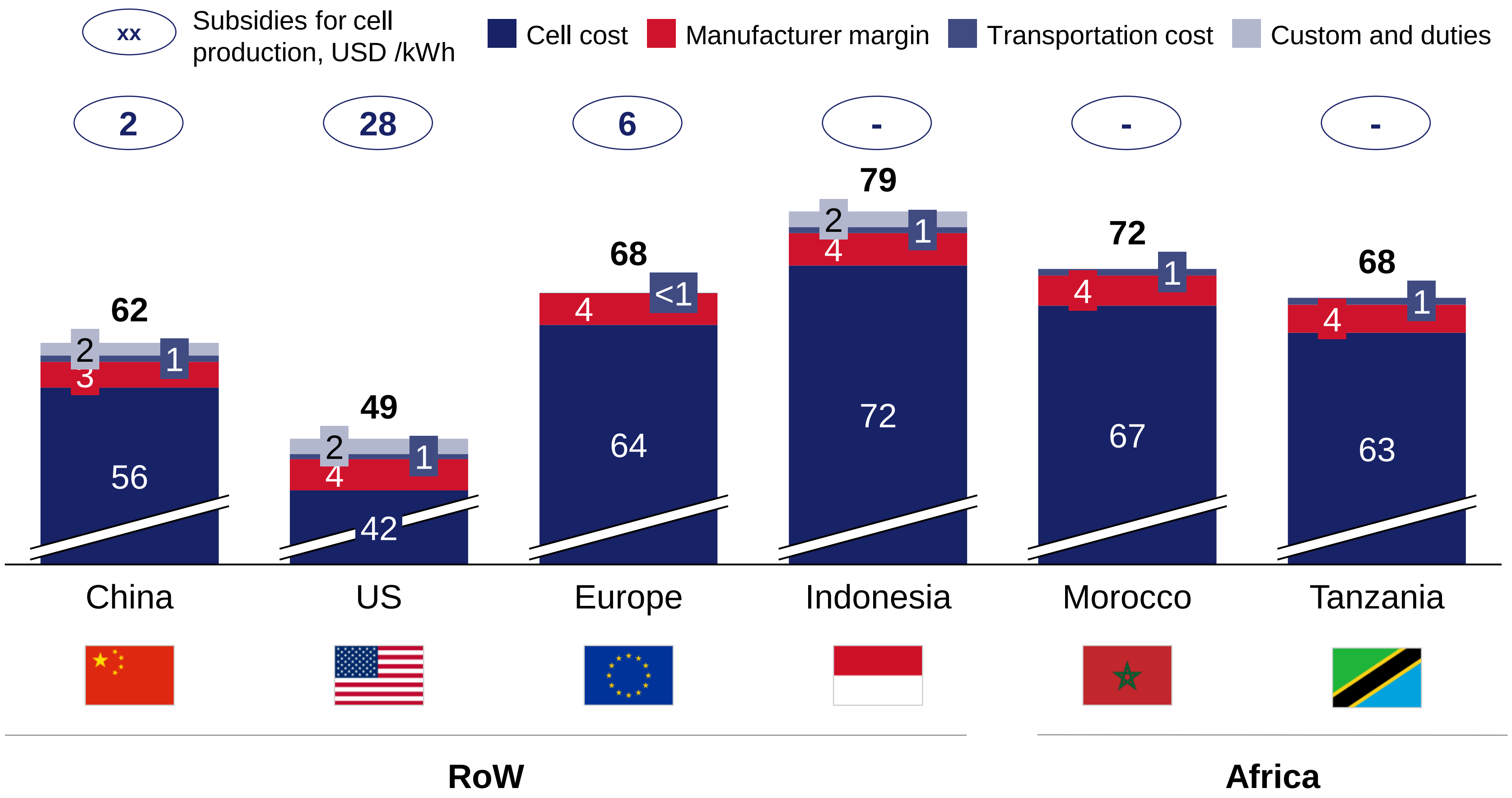
African countries face **higher capex costs** due to their **full reliance** on **Chinese technology** for building **gigafactories**

Morocco and Tanzania are poised to remain competitive against Europe in 2030, but governments would need to implement subsidy programs to effectively compete with RoW

ANALYSIS INCL. COUNTRIES SUBSIDIES AS OF JULY 2024

EXAMPLE FOR MOROCCO AND TANZANIA, REPRESENTATIVE OF COUNTRIES WHICH COULD POTENTIALLY PRODUCE CELLS

Expected landed cost by country to serve an OEM in Europe, USD/kWh



Key insights

Despite the **subsidies** provided by China, US, and Europe, **Tanzania** and **Morocco** can still remain competitive in **exporting to the EU**, assuming **EU OEMs** seek to **reduce reliance** on **Chinese imports**, and the **US would have LFP undersupply** by 2030, prioritizing to serve their **domestic market**

Despite their proximity to **OEMs,** EU countries **would not have** a significant competitive advantage in producing **LFP cells** compared to African countries as transportation cost account for only **1-3%** of the **total landed cost**

Chinese producers can afford to operate with **lower margins** compared to producers in other countries, thanks to their **secured demand** for **large volumes**

Source: Battery Insights, Expert interviews

For Morocco and Tanzania to emerge as Europe's preferred LFP providers, certain external factors should align

EXAMPLE FOR MOROCCO AND TANZANIA, REPRESENTATIVE OF COUNTRIES WHICH COULD POTENTIALLY PRODUCE CELLS

● High ○ Low

External factors	Potential pathways to success for African countries	Feasibility[1]
Reducing dependency on Chinese imports	Europe would endeavour to reduce its **dependence on Chinese LFP imports,** recognizing the **significant pricing challenges** African countries face in competing with **China** for LFP exports	◐
Insufficient EU cell production to meet local demand	By 2030, **European cell producers** would **be unable** to meet the **increasing local demand** for **LFP batteries** in Europe, driven primarily by the requirements of **major OEMs**	◕
EU accepting battery products from African countries	The EU would agree to accept **LFP batteries** from **African countries** without imposing **protective import taxes**, fostering fair competition and supporting the integration of African-produced batteries into the European market	◔
African governments allowing gigafactories to be located in SEZ	African countries would permit factories to be located in **SEZs**, enabling the import of battery materials from international countries (e.g., China) with a **0% import duty**	◕
African governments subsidizing local cell producers	To enhance the **competitiveness of African countries** in the global LFP market, **governments in the region** should consider providing **subsidies** aimed at supporting **local battery cell manufacturing initiatives**	◐

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1. Assessment based on Expert interviews

Source: Expert interviews

Battery manufacturing value chain

Battery value chain	Raw materials		Cell components				Cell production		Battery pack		Recycling
	Mining	Refining	Anode	Cathode	Electrolyte	Separator	Mobility	BESS	Mobility	BESS	
Features of target African countries	**Presence of important reserves and mines** of raw materials	**Presence of mining operations** for relevant raw materials High **occupational safety and health** Reliable and cost competitive **electricity**	**Presence of refineries** of relevant raw materials **Cost competitive to compete in the global value chain** or have sufficient local demand		**Presence or proximity** to materials (incl. refined lithium)	**Presence or proximity** to refined oil products	**Proximity to OEMs** Availability **of skilled staff** **EPCs with expertise** in specialised rooms	**High renewable energy** share in electricity mix Availability **of skilled staff** **EPCs with expertise** in li-ion rooms	**Proximity to end market** **Cost** competitiveness Competencies in **software and hardware integration**		**Access to feedstock of second-life batteries**

Focus of this section

Source: Expert calls, McKinsey Battery Insights, AREMI

We have looked at 4 important themes to assess Africa’s opportunities in battery assembly for electric two-/three-wheeler applications

What does battery assembly for electric two-/three-wheeler applications mean?

Assumptions for target projects

Key success factors

Who are active players in Africa and what are the challenges?

Africa could backward integrate into electric two-/three-wheeler components manufacturing to create more value in the continent

NON EXHAUSTIVE

Value chain of electric two-/three-wheelers

▨ Africa's current play 🟥 Potential play for Africa

Value chain step	**Raw materials**	**Battery cell production**	🟥 **Electric two-/three-wheeler components manufac-turing**	**Vehicle integration and testing**	**Import and dealer chain**	**Asset provider chain**	**Charging and maintenance**	**Mobility services**
Descrip-tion	Mining, refining, and active material production	Design, production, and sale of battery cells	Design, production, and sale of battery packs, HW and SW components (integrating BMS), and powertrains	Design, integration, testing, and sale of (purpose-built) vehicles	Import, distribution, and retail of vehicles	Provision of financing for vehicle ownership and insurance services for vehicles	Charging of vehicles, incl., energy consumption Maintenance of vehicles, e.g., repair, aftermarket services, cleaning	Provision of mobility services to the end customers, e.g., via smartphone application
Example players <non-exhaustive>		SAMSUNG SDI LG Chem	SHIMANO BOSCH Valeo TEKTRO	Electric two-/three-wheeler assemblers GIANT CUBE dodai E-mobility for Africa TREK	Importers ZOLL B.O.C. Fahrrad XXL	Finance providers, e.g., banks Deutsche Bank ERGO Allianz	Garages and car washes bikepick swiftmile cyclecure Swobbee	FREENOW DiDi UBER moovel Google

Key insights

Africa could backward integrate **electric two-/three-wheeler components manufacturing, especially battery pack assembly**

Africa could **import battery cells and assemble battery packs** since it can be started on a **small scale with limited capex,** and it is **preferential for electric two-wheeler OEMs to assemble battery packs locally and reduce cost** (considering the OEMs have sufficient demand)

Source: McKinsey Energy Storage Insights, Expert interviews, GTM research

We formulated hypotheses to outline key assumptions for successful battery pack assembly for electric two-/three-wheeler projects in Africa

Key questions	Current hypotheses
What does battery module assembly for electric two-/three-wheeler applications entail?	**Importing the battery cells and BMS** from the international market (countries which are cost-competitive in cell production) and **assembling battery modules** (the design of the battery pack could be different based on customer needs)
What is the ideal plant size to be cost-competitive?	1 GWh battery pack assembly
What end market should be the target?	The **growing local (country-level) electric two-/three-wheeler** demand and **export to other African countries in the region.** In Africa, 2.6-3.1 GWh electric two-wheeler battery demand
What type of battery chemistry should be assembled for electric two-/three-wheeler application?	• For most electric two-/three-wheelers, **LFP chemistry is selected due to its low cost compared to NMC,** NMC is typically reserved for high-end EVs • Form factor (Cylindrical, Prismatic, Pouch) would depend on the customer's specific need
Where could the plant be located?	Countries with a **large demand and existing ecosystem of electric two-/three-wheeler** (top potential countries: Nigeria, Kenya, Egypt, Ethiopia, Uganda, Ghana, Tanzania, Ivory Coast, Morocco, and Malawi)
What is the typical capex required for a battery module assembly facility?	**USD 2-5 mn** (a capex of USD ~2 mn is required to set-up a 1 GWh battery pack assembly line with 9,000 square meters and a workforce of 150 employees)
Will local manufacturing be cost competitive?	Africa could be cost-competitive on two-/three-wheeler battery assembly by creating efficient supply chain management, bulk procurement of components, optimized logistics, and ensuring the required government incentives are in place (e.g., financial incentives for local production)

Note: Batteries for four-wheeler EV vehicles are complex. Manufacturers usually set up factories close to automotive manufacturers (OEMs), as battery design needs to be tailored to the vehicle that it will go into. As there are no large four-wheeler EV manufacturing industries in Africa outside of Morocco, it seems unlikely that four-wheeler EV battery assembly is an opportunity for the continent at this time

Source: Expert interviews

We identified 4 main factors for countries to be cost-competitive in battery pack assembly for electric two-/three-wheeler application

Success factors	Potential pathways to be successful for African countries	Successful example
Access to high-quality battery pack components at low cost and efficient procurement	**Guarantee access to high-quality battery components at low cost** (Battery cell sourcing is the largest-cost item for electric two-wheelers and forms 30- 40% of the bill of material)	🇨🇳 China is a major producer of Li-ion batteries and has streamlined supply chains, enabling efficient component procurement. Companies like CATL and BYD are prominent players in the Chinese battery market
Sufficient local demand to create an economy of scale	Ensure there is a **high demand for electric two-/three-wheeler** and the **existence of local electric two-/three-wheeler assemblers** that are willing to buy from local battery module assemblers To drive demand, **create an e-mobility ecosystem** such as battery swapping service and charging infrastructure and **incentivise e-mobility adoption**	🇮🇳 With its growing electric two-wheeler market, India has seen increased demand for battery modules. Companies like Ola Electric and Ather Energy are capitalising on this demand, creating economies of scale, and driving down costs
Design and R&D expertise	**Acquire skills required to design battery packs,** select the proper components, and perform continuous improvement (the design of the battery pack could be different based on customer needs)	🇯🇵 Japan, known for its engineering excellence, has companies like Panasonic and GS Yuasa that specialise in battery module design and innovation
Available infrastructure required to export	**Provide access to export market** (improved transportation infrastructure and export policies) considering the need to export to neighbouring countries to grow market size	🇨🇳 China has a strong export market for electric scooters and e-rickshaws. Companies like Niu Technologies and Yadea have successfully expanded their electric two- and three-wheeler offerings to international markets, demonstrating their export capabilities

Source: Expert interviews

Several players are already active in Africa and have identified challenges and support required to succeed

ILLUSTRATIVE **NON EXHAUSTIVE**

Players active in Africa in the EV market[1]

dodai
E-mobility for Africa

KABISA

JOKOSUN
easy energy |everywhere

POSSIBLE EVS

solarbox

Challenges identified

- **Lack of supportive government regulations** to encourage the use of EVs and help make EVs price competitive
- **Lack of design standards in electric two-wheeler batteries:** This makes the market uncertain, e.g., for companies considering doing battery swaps
- **Customer demand is nascent:** Slow uptake of new technologies necessitates proving the reliability and effectiveness of EVs to early adopters and work is required to raise awareness
- **Lack of charging infrastructure investment:** Governments or private companies need to invest in local charging infrastructure in order to make it viable for local companies to manufacture EVs for domestic consumption
- **Lack of financing:** There is limited access to financing to set up the manufacturing/local assembly sites

Support required to succeed

- **Favourable government policies** to encourage the use and switch towards electric mobility – such moves would reduce risks for companies and help grow demand in the market
- **Awareness raising on the benefits of electric transportation/e-mobility** to help grow demand on the consumer side
- **Technical assistance:** To share market insights into customer needs for both commercial and passenger EVs to tailor offerings effectively
- **Financing** to help companies secure upfront capital

Note: Most of the players in this space currently import batteries made externally and assemble the EV

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1. Incl. players assembling EV batteries and players providing EV battery products through imported batteries; incl.players focused on EVs and electric boats

Source: Stakeholder interviews

We have looked at 4 important themes to assess Africa’s BESS assembly opportunities

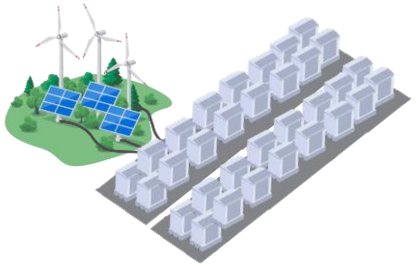
What is BESS assembly?

Assumptions for target projects

Key success factors

Who are active players in Africa and what are the challenges?

BESS serve applications across the entire energy landscape



	Front-of-the-meter (FTM) utility	Behind-the-meter (BTM) commercial and industrial (C&I)	Behind-the-meter (BTM) residential
Typical size	> 10MWh	30 kWh–10 MWh	<30 kWh
Use cases	Utility scale BESS • Price arbitrage • Long-term capacity payments • Ancillary service markets • De-risk renewable generation • Investment deferral	Uninterruptable Power Supply (UPS) Renewable integration (rooftop photovoltaic) Power cost optimization EV charging infrastructure	Home integration • Renewable integration (rooftop photovoltaic) • EV charging infrastructure
Key customers	Utilities, EPCs	Commercial end customers (e.g., hospitals, data centres) Industrial end customers (e.g., manufacturing, mining, metals and chemicals)	Households

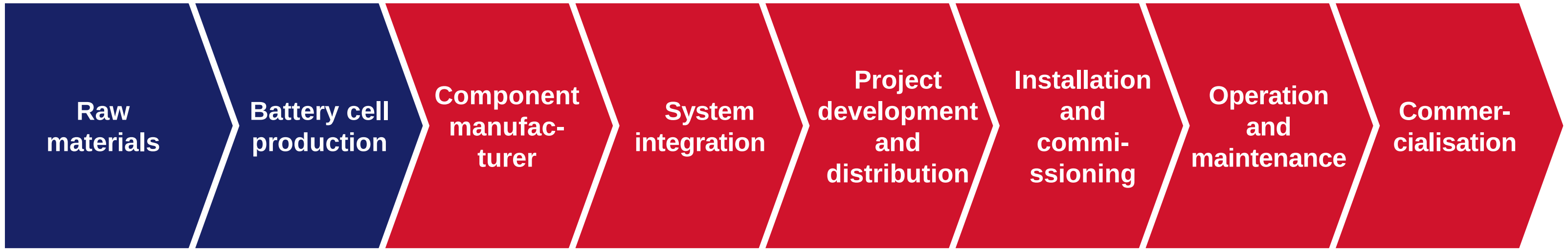
Source: McKinsey Energy Storage Insights

Most value in the BESS value chain is found in the upstream hardware as well as in the optimisation of BESS revenues

NON EXHAUSTIVE **PERSPECTIVE AS OF Q3 2023**

Value chain of BESS

🟥 Potential play for Africa



Value chain step	Raw materials	Battery cell production	Component manufacturer	System integration	Project development and distribution	Installation and commissioning	Operation and maintenance	Commercialisation
Description	Mining, refining, and active material production	Design, production, and sale of battery cells	Manufacturing of modules, power components (inverters), as well as auxiliary hardware (controllers, containers)	Integration design and assembly, incl. Energy Management System (EMS) and grid optimisation software	Project development, marketing, financing, permitting, negotiation	EPC and interconnection hardware, physical installation	Service to ensure continued operation of the BESS	Optimisation of revenues generated by BESS

Example players <non-exhaustive>

Tesla

Samsung SDI
CALB
CATL
northvolt

KOSTAL
SMA
Growatt
Fronius
Siemens

BYD
Schneider Electric
Huawei
LG Energy
Panasonic
ABB

sonnen
Energy Vault
Varta
Fluence
aggreko

1KOMMA5°
upowa
octopus energy
smsplc
Enpal
sunrun
Harmony Energy
engie
Zenobe
EKU
enel
RWE
Iberdrola
X-Elio
EDF renouvelables

Key insights

Africa could play in the system integration step of the value chain and integrate downstream

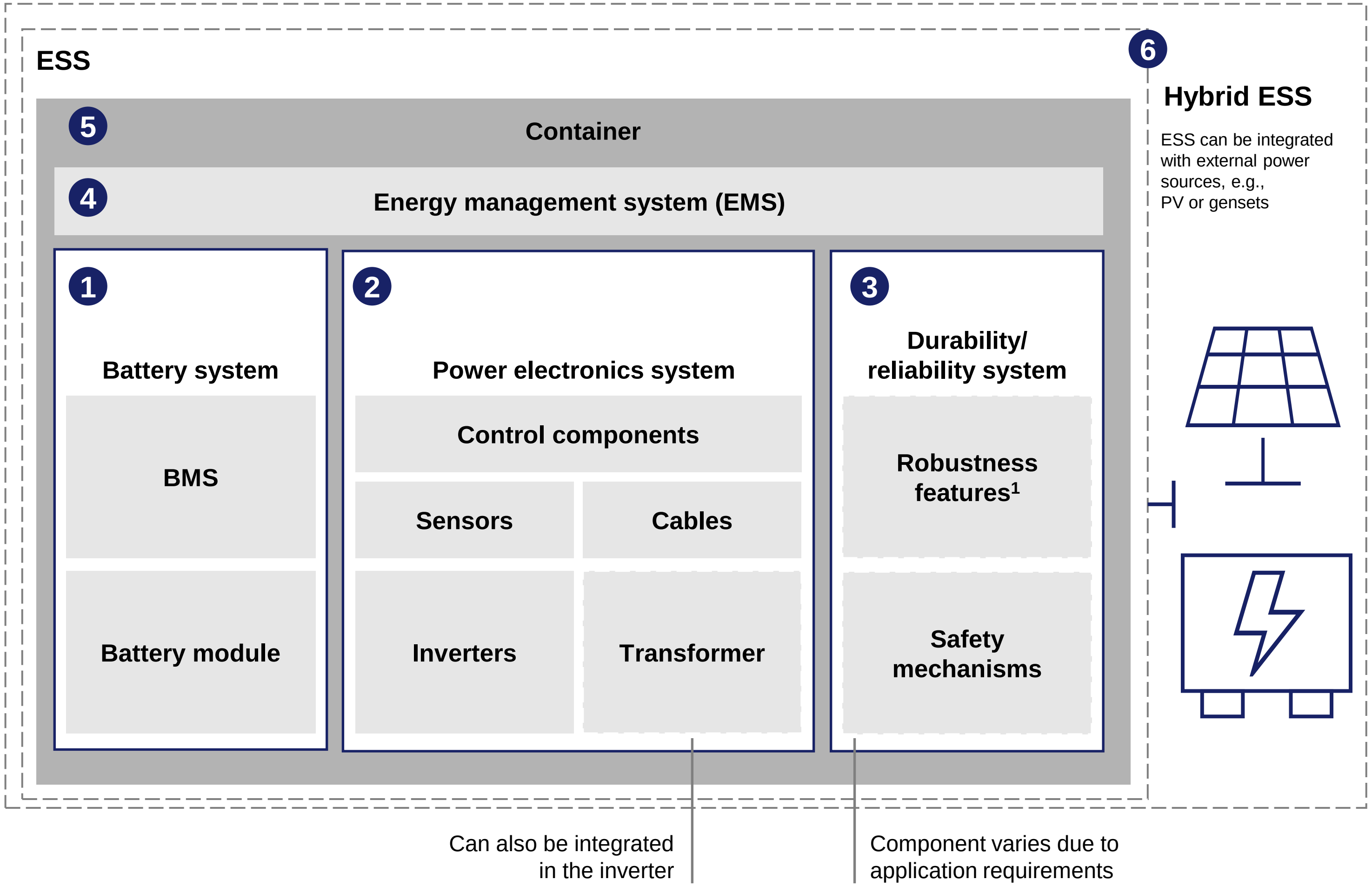
Africa could import battery cells and assemble battery packs since it can be started on **small scale with limited capex**

Power hardware, software and controls, and support systems components could also be **imported and assembled with the battery modules** to create the BESS

Source: McKinsey Energy Storage Insights, Expert interviews, GTM research

The role of an energy storage system integrator

PERSPECTIVE AS OF Q3 2023



The system integrator activities

1. The system integrator chooses and sources the battery system based on application requirements
2. Design of power electronics system and sourcing of components
3. Based on application requirements, design the system to withstand harsh environments and meet safety requirements
4. The system integrator selects/develops the EMS according to the application requirements and integrates it with the hardware
5. The system integrators piece together all components in the container to form a solution
6. Integration of ES to genset or PV to form a hybrid ESS solution

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1. Incl. features to withstand harsh environments, e.g., vibration resistance, temperature resistance, humidity resistance

Source: Expert interviews

We formulated hypotheses to outline key assumptions for successful BESS assembly projects in Africa

Key questions	Current hypotheses
What does BESS assembly mean?	• **Design the BESS system** • **Import all components required:** battery cells, BMS (could be produced locally after developing the expertise), power hardware, etc. • **Assemble the battery module** and integrate the remaining components
What is the ideal plant size to be cost-competitive?	Economy of scale or **size is not as crucial as for battery cell manufacturing** (there are multiple successful small size players)
What end market should be the target?	The **growing local (country-level) BESS demand and export to other African countries** in the region. In Africa, there could be a total of ~56 GWh electric BESS demand by 2035
Which BESS segment should we target?	BESS **demand for residential and small commercial applications** considering the manufacturing complexity and capex required to set up large C&I and utility BESS manufacturing facilities (e.g., the need to develop a SCADA system)
What type of battery chemistry should be selected for BESS?	For most BESS applications, **LFP chemistry is selected due to its low cost compared to NMC;** NMC is typically reserved for high-end EVs
Where could the plant be located?	**Countries with high BESS demand** (share of renewable energy sources) **or available battery cell manufacturing** (top potential countries: Egypt, South Africa, Morocco, Algeria, Zambia, Kenya, Namibia, Angola, Nigeria, and Togo; countries with high demand or cell production)
What is the typical size of investment required for a BESS assembly?	USD 3-10 mn
Will we be cost competitive?	**Africa could be cost-competitive** due to the advantage of **reduced transit cost, time, and logistical complexities** compared to import of fully assembled batteries **Government incentives** such as reducing import taxes on components required for BESS assembly could further **help reduce costs**

Source: Expert interviews

We identified 5 main factors required for countries to be cost-competitive in BESS assembly

Success factors	Potential pathways to be successful for African countries	Successful example
Access to high-quality battery pack components at low cost and efficient procurement	**Guarantee access to high-quality battery components at low cost:** 70% of the cost of a BESS is its components (energy hardware, power hardware, software and controls, other support system)	🇨🇳 China is a major producer of Li-ion batteries and has streamlined supply chains, enabling efficient component procurement. Companies like CATL and BYD are prominent players in the Chinese battery market
Sufficient local demand to create an economy of scale	**High share of renewable energy sources** in the total energy production mix **Insufficient and unreliable grid** pushing residents and business owners towards BESS installation	🇺🇸 The US has seen significant growth in energy storage demand. Tesla, with its Powerwall and Powerpack products, has capitalised on this demand, creating economies of scale and driving down costs
Government support towards renewable energy technology manufacturing	**Regulations that support renewable energy** sources adoption **Favourable local value-add manufacturing policies** and regulations to improve cost competitiveness	🇮🇳 A USD ~455 mn incentive to companies that set up BESS 🇨🇳 Mandatory energy storage integration requiring 10-20% generation capacity of renewable energy power plants to be stored
Design expertise	**Acquire skills required to design battery packs,** select the proper components, and perform a continuous improvement	🇩🇪 Germany has companies like Sonnen and VARTA that specialise in energy storage system design and innovation
Capability to export	**Provide access to export markets** (improved transportation infrastructure and export policies) considering the need to export to neighbouring countries to grow market size	🇰🇷 South Korea, home to LG Chem and Samsung SDI, has successfully exported battery technologies globally. These companies have a strong presence in the international market

Source: Expert interviews, press search

Several players are already active in Africa and have identified challenges and support required to succeed

ILLUSTRATIVE **NON EXHAUSTIVE**

Players active in Africa in the BESS market[1]

arnergy

DUPLANTIS
Energy Limited

D&S DAVIS & SHIRTLIFF
know H2Ow through experience

EAUXWELL

solar shop

NEVADICSOLAR

zettaJoule
Energy Storage

SLSEnergy

Challenges identified

- **Cell quality control:** Inconsistent battery tier ratings by manufacturers has led to difficulties in sourcing batteries and cells
- **Battery quality control:** As a result of poor quality control measures, manufacturers/suppliers sometimes fail to properly label batteries' depth of discharge, leading to returns from customers
- **Lack of financing:** Due to local investors" lack of interest in manufacturing, preventing manufacturers' ability to manufacture at scale and be cost competitive with imports
- **Custom difficulties:** Import tariffs and delays at customs make it difficult to import cells
- **Difficulty in finding a technology partner:** The fast-changing battery technology is forcing players to either invest in R&D or have a technology partner

Support required to succeed

- **Access to financing,** often to set up a first pilot plant to show that manufacturing is possible locally
- **Access to market information,** such as market size, target regions, and customers to help companies focus their efforts
- **Favourable government policies** on renewable energy technology (incentivise local value-add, develop product standards, etc.)
- **Technical assistance** to conduct pre-feasibility studies, help local upskilling, and support companies in finding technology partners

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1. Includes players assembling BESS batteries and players providing BESS services/products through imported batteries

Source: Stakeholder interviews

Battery manufacturing value chain

Battery value chain	**Raw materials**		**Cell components**				**Cell production**		**Battery pack**		**Recycling**
	Mining	**Refining**	**Anode**	**Cathode**	**Electrolyte**	**Separator**	**Mobility**	**BESS**	**Mobility**	**BESS**	
Features of target African countries	**Presence of important reserves and mines** of raw materials	**Presence of mining operations** for relevant raw materials High **occupational safety and health** Reliable and cost competitive **electricity**	**Presence of refineries** of relevant raw materials **Cost competitive to compete in the global value chain** or have sufficient local demand		**Presence or proximity** to materials (incl. refined lithium)	**Presence or proximity** to refined oil products	**Proximity to OEMs** Availability **of skilled staff** **EPCs with expertise** in specialised rooms	**High renewable energy** share in electricity mix Availability **of skilled staff** **EPCs with expertise** in li-ion rooms	**Proximity to end market** **Cost** competitiveness Competencies in **software and hardware integration**		**Access to feedstock of second-life batteries**

Focus of this section

Source: Expert calls, McKinsey Battery Insights, AREMI

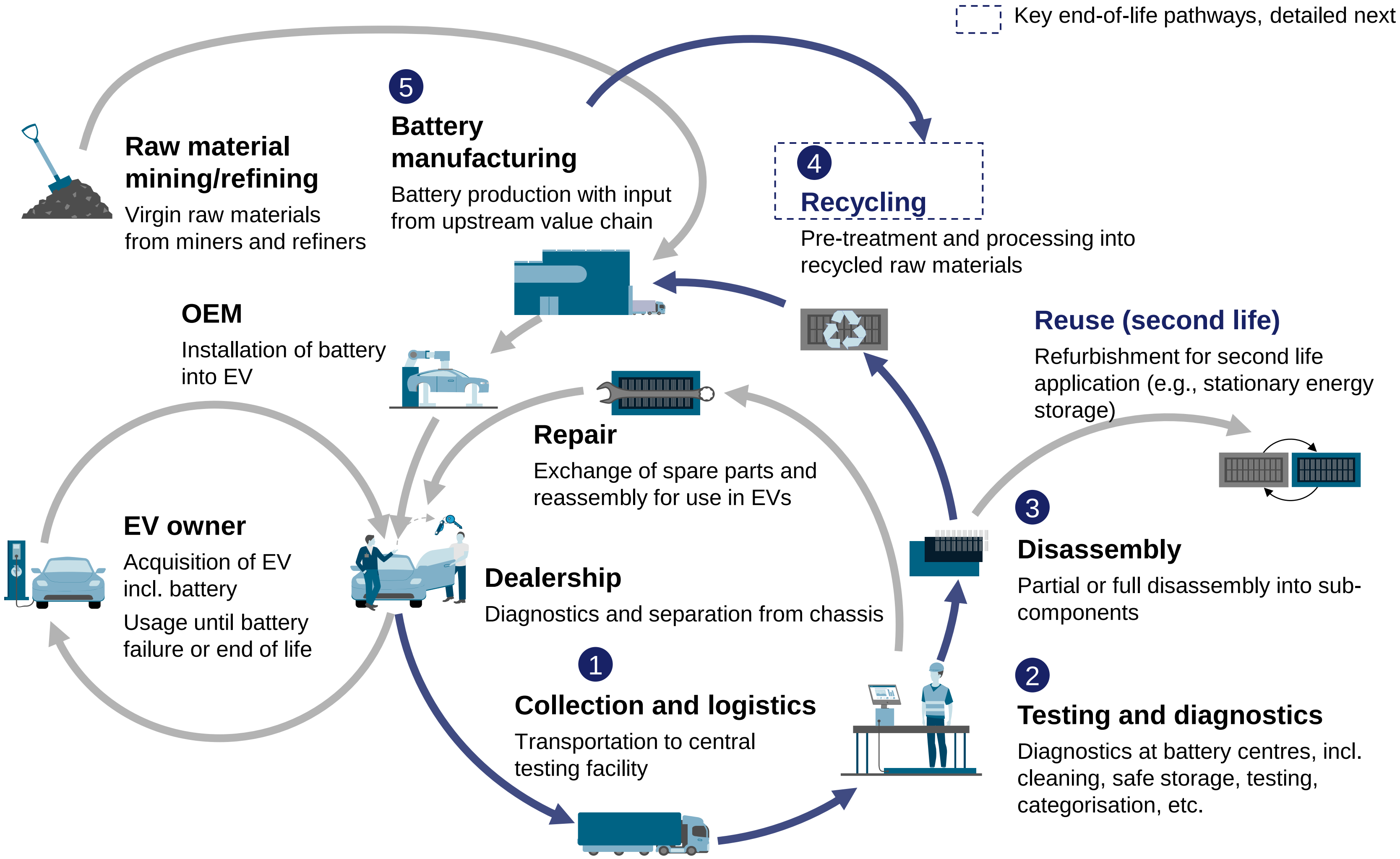
We have looked at 3 important themes to assess Africa’s recycling opportunities

What is battery recycling?

Key success factors

Who are active players in Africa and what are the challenges?

Recycling is one of the many steps that can happen at the end of life of a battery



⬚ Key end-of-life pathways, detailed next

Raw material mining/refining
Virgin raw materials from miners and refiners

⑤ **Battery manufacturing**
Battery production with input from upstream value chain

OEM
Installation of battery into EV

EV owner
Acquisition of EV incl. battery
Usage until battery failure or end of life

Dealership
Diagnostics and separation from chassis

Repair
Exchange of spare parts and reassembly for use in EVs

① **Collection and logistics**
Transportation to central testing facility

② **Testing and diagnostics**
Diagnostics at battery centres, incl. cleaning, safe storage, testing, categorisation, etc.

③ **Disassembly**
Partial or full disassembly into sub-components

④ **Recycling**
Pre-treatment and processing into recycled raw materials

Reuse (second life)
Refurbishment for second life application (e.g., stationary energy storage)

Key challenges for end-of life management of batteries

① **Expensive logistics** due to high battery weight and special requirements for dangerous goods

②③ **Inefficient processes** due to lack of standardisation and low transparency from OEM/battery manufacturer on battery content and structure

④ **Fragmentation of recycling processes and low yield** due to non-standardised batteries and immature technologies

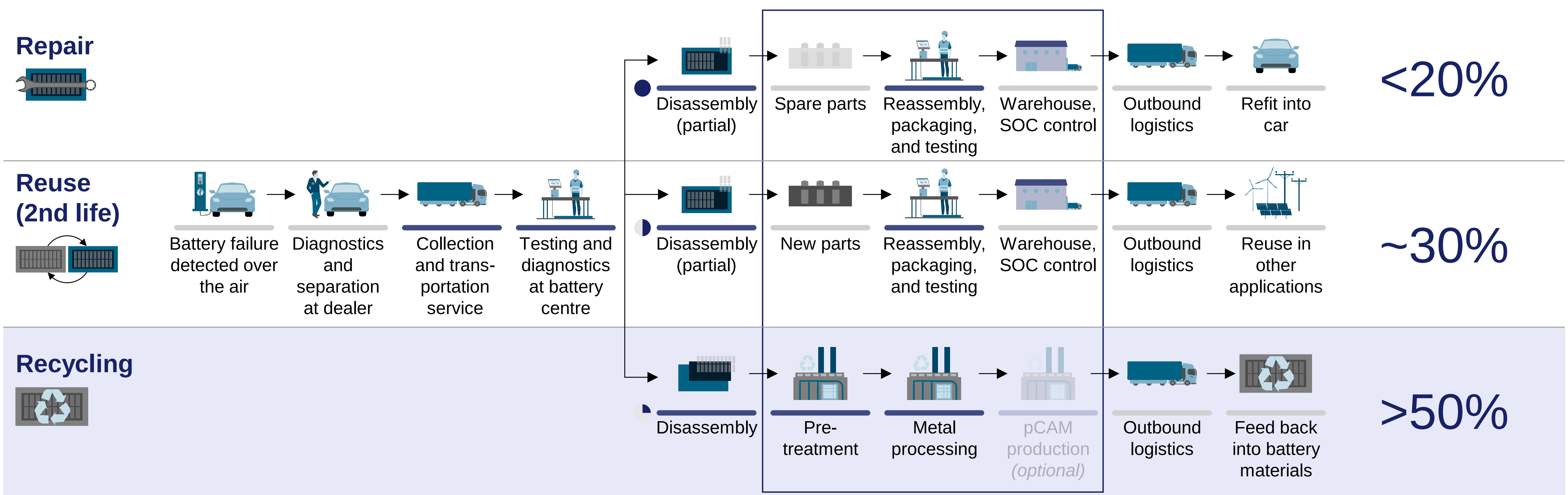
⑤ **Preference towards virgin raw materials** due to existing sourcing processes and experience

Source: McKinsey

Depending on the remaining value, the battery takes 3 end-of-life paths with different processing steps

ILLUSTRATIVE

▭ Detailed next pages **Remaining battery value/performance** ◔ Low ◑ Medium ● High ☐ Key differences — Key cost drivers

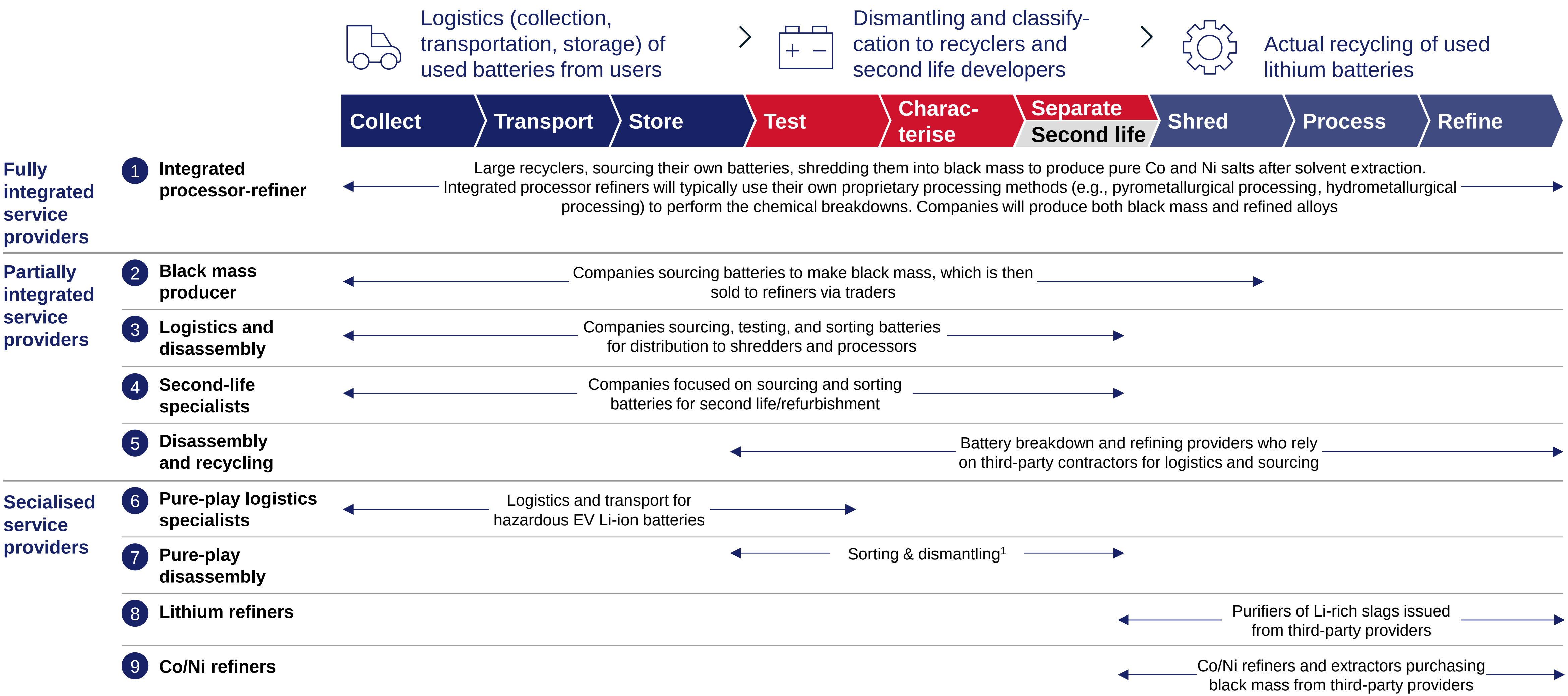


	Collection and logistics			Testing and disassembly		Handling and processing			Usage		Expected 2030 battery pass through, in Gwh
Repair					● Disassembly (partial)	Spare parts	Reassembly, packaging, and testing	Warehouse, SOC control	Outbound logistics	Refit into car	<20%
Reuse (2nd life)	Battery failure detected over the air	Diagnostics and separation at dealer	Collection and transportation service	Testing and diagnostics at battery centre	◑ Disassembly (partial)	New parts	Reassembly, packaging, and testing	Warehouse, SOC control	Outbound logistics	Reuse in other applications	~30%
Recycling					◔ Disassembly	Pre-treatment	Metal processing	pCAM production *(optional)*	Outbound logistics	Feed back into battery materials	>50%

Battery recycling can be done through **pyrometallurgical recycling** (high heat), **hydrometallurgical recycling** (chemicals) or **direct recycling** (retaining the composition of the cathode material); there is no consensus on the best method

Source: McKinsey Battery Insights, GIZ

The EV battery recycling value chain sees 9 business model archetypes, ranging from integrated service provider to specialist



Logistics (collection, transportation, storage) of used batteries from users

Dismantling and classify-cation to recyclers and second life developers

Actual recycling of used lithium batteries

Collect | Transport | Store | Test | Charac-terise | Separate / Second life | Shred | Process | Refine

Fully integrated service providers

① **Integrated processor-refiner**: Large recyclers, sourcing their own batteries, shredding them into black mass to produce pure Co and Ni salts after solvent extraction. Integrated processor refiners will typically use their own proprietary processing methods (e.g., pyrometallurgical processing, hydrometallurgical processing) to perform the chemical breakdowns. Companies will produce both black mass and refined alloys

Partially integrated service providers

② **Black mass producer**: Companies sourcing batteries to make black mass, which is then sold to refiners via traders

③ **Logistics and disassembly**: Companies sourcing, testing, and sorting batteries for distribution to shredders and processors

④ **Second-life specialists**: Companies focused on sourcing and sorting batteries for second life/refurbishment

⑤ **Disassembly and recycling**: Battery breakdown and refining providers who rely on third-party contractors for logistics and sourcing

Secialised service providers

⑥ **Pure-play logistics specialists**: Logistics and transport for hazardous EV Li-ion batteries

⑦ **Pure-play disassembly**: Sorting & dismantling[1]

⑧ **Lithium refiners**: Purifiers of Li-rich slags issued from third-party providers

⑨ **Co/Ni refiners**: Co/Ni refiners and extractors purchasing black mass from third-party providers

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1. May include interim storage of sorted and dismantled parts (warehousing) for pickup by transport and logistics provider

Source: Expert interviews, Markets & Markets, press search, McKinsey Battery Demand Model

We identified 5 main factors required for countries to be cost competitive in battery recycling

Success factors	Potential pathways to be successful for African countries	Successful example
Secure access to large amounts of battery waste	**Develop schemes or strategic partnerships to facilitate access to battery waste,** either locally or through imports, as economies of scale are essential in recycling	Panasonic announced a scheme to collect and recycle used dry batteries through 7-Eleven stores in Thailand, facilitating the collection of end-of-life batteries In Japan, several car manufacturers have formed an alliance for battery recycling (represented by Toyota, Honda, etc.)
Note: Access to large amounts of batteries to recycle locally is critical for battery recycling plants to be profitable, as damaged and end-of-life cell require safety transport and are 3-4x as expensive to ship vs. normal cells and 5-8x times more expensive than black mass[1] by weight		
Proximity to efficient logistics	As black mass[1] or refined materials will need to be exported, possess **adequate infrastructure** for **facilitating imports** and **exports,** incl. roads, railway stations, and port access, or **governments** should commit to making **substantial** and **rapid investments** to achieve these infrastructure levels	Redwood Materials set up an anode recycling plant in North Carolina, home to the automotive industry, incl. Redwood's partners (Toyota, Volvo, Panasonic and Envision AESC) SungEel HiTech is planning to recycle batteries in Spain and ship black mass to South Korea
Access to low-cost green and reliable energy	Ensure **access to sufficient energy** for the energy-intensive recycling processes **Renewable energy is preferred** since the EU market is prioritising low-emission refined active materials to achieve their emission targets	The EU Green Deal established a cap on battery carbon footprint by 2027
Government regulations to encourage battery recycling	**Regulations that support formal sourcing** of battery waste and encourage citizens to recycle batteries	The EU Green Deal requires specific recycling quotas and the inclusion of recycled content, e.g., at least 80% lithium must be recovered when recycling the battery from 2031
Develop process expertise	**Implement innovative processes** that will maximise the recovery of recycled components whilst minimising emissions and waste	Redwood Materials' innovative hydrometallurgical process enables 80% less energy use, 70% less CO_2 emissions, and 80% less water usage

Note: There is currently insufficient accessible battery waste in Africa to make it profitable for a company to build a large battery recycling plant. Securing access to battery waste will be a key first step in making large-scale recycling projects succeed; production scrap is likely to be a key source of recycled materials in the coming years

Way forward: Considering a typical battery lifetime (10-20 years for BESS and EVs), African countries considering implementing electrification policies and programs (e.g., EVs, zero emissions generators, BESS) should consider viable strategies and technologies for battery recycling and disposal to mitigate end-of-life environmental impacts and access climate finance. This is an area where governments and development partners could work together to assess the different solutions available, incl. leveraging existing technology currently developed in other regions

1. Black mass is a fine podwer that contains anode and cathode active materials after they have been transformed by a thermomechanical process

Source: Expert interviews, press search

Several players are already active in Africa, and have identified several challenges and support required to succeed

ILLUSTRATIVE **NON EXHAUSTIVE**

Players active in Africa in the battery recycling market[1]

SLS Energy

Hinckley
RECYCLING

Challenges identified

- **Informal waste collection sector:** Making it difficult for many companies to source large enough amounts of e-waste to recycle and be profitable
- **Lack of supply chain visibility:** Understanding the supply chain output, incl. the quantity and quality of second-life batteries, is crucial for securing battery cells
- **Battery quality:** There is a lack of visibility and traceability of the quality and technical aspects first-life batteries, posing challenges in managing the second-life battery supply
- **Lack of government regulations:** Lack of regulations to recycle e-waste, or lack of implementation when they exist, create hurdles for private companies

Support required to succeed

- **Insights into logistics and regulation** to understand the logistics and regulations surrounding battery transport from other countries, as different policies on second-life batteries and waste definitions can complicate logistics
- **Market and supply chain intelligence** to help companies develop robust market intelligence and supply chain insights is key to scaling operations
- **Favourable government policies** to incentivise the formal recycling of battery waste
- **Financing:** Securing capital is essential to increase deployment capacity and scale operations effectively

Additional work could be undertaken by Manufacturing Africa to further research specific opportunities in the battery recycling space

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[1] Incl. players recycling local and imported batteries

Source: Stakeholder interviews

Path forward – from projects to impact

4

Attracting large investments for value addition on the continent has historically been challenging

ILLUSTRATIVE

		Main challenges					
Case study	**Context**	**Poor transport infrastructure**	**Lack of adequate skilled workforce**	**Insufficient and unreliable electricity**	**Capex required to set up facility**	**Political instability and insecurity**	**Lack of enabling policies/ regulation**
Crude oil in Nigeria	*In 2022, Nigeria produced 1.1 mn b/d, from which ~99% was exported for refinery outside of the country*[11] *It had 5,000 b/d of refinery output, which is 1% of its nameplate refining capacity; however, recently opened Dangote Refinery has doubled Nigeria's refining capacity* [11]	**Damaged pipelines**, shallow channels, and the **lack of an effective logistics** framework[1]	**Inadequate training** facilities, **reduced** central government **expenditure** to skill up workforce[10]	**Limited supply of electricity** limits refining (~33 power outages in a month)[4]	**Insufficient capital allocation to refinery** maintenance/ updates[6]	**NGN >50 bn lost to pipeline vandalism** Jan-Apr 2016[1]	**Inconsistent and heavy regulation**, managed by multiple agencies[7, 8, 9], estimated loss of USD ~15 bn/year in FDI due to regulation[1]
Cobalt in DRC	*In 2022, DRC accounted for 72% of global cobalt production*[12] *However, it accounted only for 8% of global cobalt refining* [12]	**Logistical challenges** and delays in securing raw materials[2]	**Limited availability of skilled workforce** forcing refineries to import talent[5]	**Lack of reliable and sufficient electric power** hindering refining[3]	**Large capital expenditure required** combines to high political risk level making it difficult to raise capital at reasonable costs[6]	**Unstable political environment** due to ethnic conflict hindering investments[3]	**Child labour and poor working conditions** due to lack regulations hindering investors due to reputational risk[2]

Key insights

Historically, it has been very **difficult** for African countries to **develop** their own **refining capacities,** with most exporting raw materials to be refined abroad and importing finished products (e.g., oil in Nigeria)

This is partly due to **difficult political economies** of these countries, which is **complex** and **a prerequisite to the success of large-scale manufacturing projects –** *this topic has been studies extensively and has not been included in this analysis*

Similar cases across the continent indicate that a **drastic change is needed** regarding our approach to projects to make sure that history does not repeat itself

1. PWC: Nigeria's Refining Revolution | 2. World Bank: COBALT IN THE DEMOCRATIC REPUBLIC OF CONGO | 3. USGS: One hundred years of cobalt production in the Democratic Republic of the DRC | 4. CAJ News (news channel in Nigeria) | 5. allAfrica | 6. Expert input | 7. Ministry of Petroleum Resources | 8. Nigeria National Petroleum Corporation | 9. Department of Petroleum Resources 10. energypeople.com | 11. OPEC | 12. USGS

Countries that successfully build out their value chains have a comprehensive policy mix that encourages investments

NON-EXHAUSTIVE DETAILED CASE STUDIES IN BACKUP

— Set of policies that have shown to help develop refining sectors

Success factors	Description	Country examples
Have a long-term vision and implement it gradually	Implementing **changes too quickly** has been proven to **disrupt** existing industries, while a **long-term vision with clear timelines** ensures local companies can adapt to the change and have the time to invest in building local processing capacity	Indonesia proposed a timeline leading to a mineral export ban to allow for smelter development in the country. It also planned a gradual LCR[1] increase to 80% by 2030
Go beyond export bans	While export bans can **provide incentives for domestic processing**, they must be coupled with supportive policies to **ensure local firms have the capabilities and resources** to take advantage of the ban – see below	Indonesia incentivizes the downstream mineral industry and accompanies the development of the sector with equity participations
Invest in a strategic infrastructure	Prioritizing **investments in strategic infrastructure** (e.g., reliable power, transportation, and communication networks) is **critical** as their lack can hinder the development of processing facilities	Namibia is implementing a policy that focuses on the development of energy, water, transport and information and communication technologies (ICT)
Build local capabilities	Investments in **local skill development is paramount**, as companies need local labour to operate refineries and manage a complex mining value chain and long-term sustainability of the domestic processing sector	Namibia has developed a policy aimed at empowering its people through practical training and skills development
Streamline regulations	**Simplifying and harmonizing regulations** reduces bureaucratic hurdles and compliance costs to encourage investment in value-added activities and supports industrial growth	Zambia's back-and-forth policies affecting the metal downstream industry created uncertainty for stakeholders
Attract investors	Creating a **favourable environment** attracts both domestic and foreign investors by offering incentives, ensuring **stability**, providing access to finance, and **developing public-private partnerships (PPPs) and JVs**	Chile offers incentives for lithium processing and facilitated a local PPP to increase the lithium production

Key insights

African countries that want to build their refining sector would need to have a **long-term vision** with a plan to **gradually implement changes**

A set of **supportive policies** would need to be put in place to support the ban, incl. **investment in infrastructure and skill building, streamlining regulations,** and **providing attractive incentive packages for investors**

1. Local content requirement

Source: Press search, Expert interviews

To successfully implement large-scale battery-related projects, and prevent history from repeating, 3 important players need to be mobilized

Player	Stakeholders with large local demand for batteries	African governments	Global financiers
Description	Coalition of governments willing to support African countries in developing local battery-related value chains (e.g., refining)	African governments with the ambition and long-term vision to drive the development of a new sector (e.g., refining)	Coalition of global private and public financiers (incl. DFIs) willing to help secure financing for the projects and de-risk investments
Partnership purpose	Commit to sourcing African imports, e.g., to diversify supply the chain	Develop effective and impactful policies that would ensure local industries have the time to develop and become globally competitive	Ensure project financing through various instruments (incl. guarantees) to help de-risk the project and ensure rapid implementation

From Minerals to Manufacturing

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