From Minerals to Manufacturing

Africa's Competitiveness in Global Battery Supply Chains

Final Report – Annexure

October 2024

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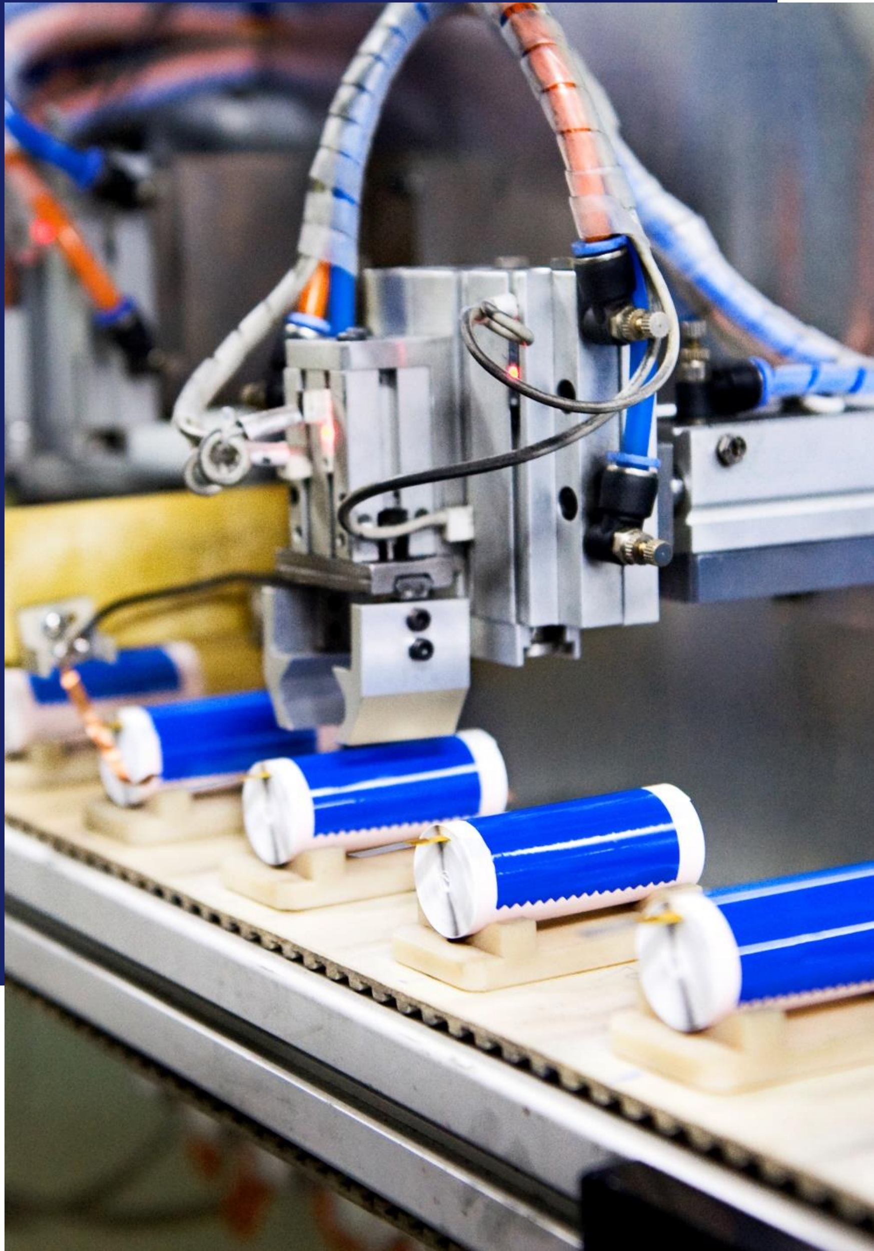

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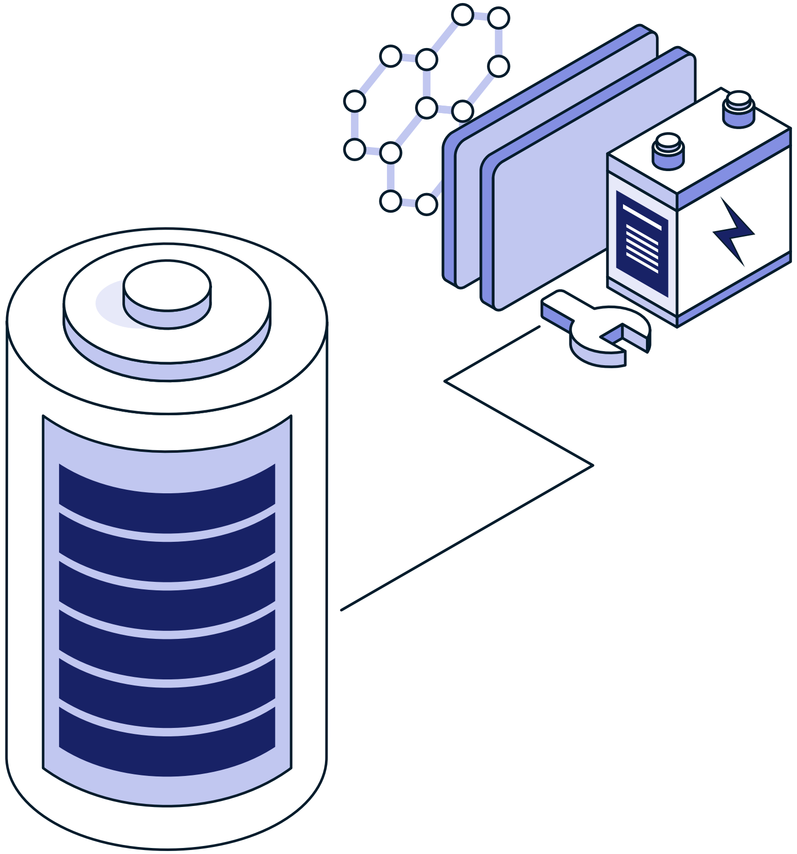
Overview of battery components

1

Batteries are composed of cells containing different components, amongst which anode, cathode, and electrolyte



	Major raw material	Main driver for[1]
Anode	6 **C** **Carbon** 12.01 14 **Si** **Silicon** 28.08 + Gra-Si blends + Li metal	(Charging) power Number of cycles
Electrolyte (and separator)	+ Liquid/polymer + Polyolefin	Safety
Cathode	3 **Li** **Lithium** 6.94 25 **Mn** **Manganese** 54.93 13 **Al** **Aluminium** 26.98 27 **Co** **Cobalt** 58.93 28 **Ni** **Nickel** 58.69	Sustainability Energy density[2] Cost

1. NB: each component affects all performance indices
2. Main driver for EV range or consumer electronics dimensions

Source: McKinsey Battery insights

Market sizing

2

Electric two-/three-wheeler battery demand sizing methodology and assumptions

DETAILED ASSUMPTIONS (INCL. SOURCES IN FOLLOWING PAGES

Market sizing steps	Methodology	Key high-level assumptions
Sizing of historical two/three-wheelers fleet in 2020	Sized the **2020 two/three-wheelers fleet** from all the **54 African countries** by leveraging historical data *(~24.6 mn motorcycles in Africa in 2020)*	• In 2020, all motorcycles in the fleets of African countries were ICE
Estimation of two/three-wheelers fleet size in 2030	Derived the **expected annual sales of motorcycles** (both ICE[1] and BEV[2]) from 2024 to 2030 by leveraging estimations from Statista, which are based on a **selection of different forecasting techniques** tailored to the behavior of the specific market	• Considered sales for on-road motorcycles, off-road motorcycles, and scooters (excl. models under 50cc category) • An average motorcycle useful life of 10 years
Development of EV adoption curves	Developed **3 different EV adoption curves** from **2023** to **2030** to allocate the **size of future sales** that will be **ICE** vs. **BEV** for each country in scope	• Low EV adoption curve ranges from 1% in 2023 to 10% in 2030 • Medium EV adoption curve ranges from 2% in 2023 to 15% in 2030 • High EV adoption curve ranges from 5% in 2023 to 40% in 2030
Allocation of EV adoption curve to African countries in scope	Allocated the **3 different EV adoption curves** to each of the African countries in scope based on: • **Their trends in fuel prices** (main driver) • The **regulatory activity related to EVs**	• Countries with higher fuel prices would experience a higher EV adoption curve as it becomes more beneficial to switch to EVs • Countries with a favourable EV regulatory environment (e.g., duty-free import of EV parts, reduced taxes on assembled EVs) have a higher EV adoption curve in the coming years
Estimation of 2030 demand for electric two-/three-wheeler batteries in GWh	Derived the **2030 demand for electric two/three-wheeler batteries** in GWh by developing 2 scenarios based on the **expected adoption of battery-swap vs. battery charge** technology (~2.6-3.1 GWh of battery demand in 2030)	• ***Conservative scenario:*** 50% adoption of battery SWAP and 50% adoption of battery charge from 2024 to 2030 • ***Aggressive scenario:*** 75% adoption of battery SWAP and 25% adoption of battery charge from 2024 to 2030

Note: Countries excluded from the analysis due to unavailability of data: Cape Verde, Central African Republic, Comoros, DRC, Djibouti, Eritrea, Eswatini, Guinea-Bissau, Liberia, Libya, Mali, Mauritania, São Tomé and Príncipe, Somalia, South Sudan

Source: Team analysis

The African two-/three-wheeler fleet is expected to grow at a ~7% CAGR from 2024 to 2030, driven by an increasing commercial and private demand for motorcycles especially in Western and Eastern Africa

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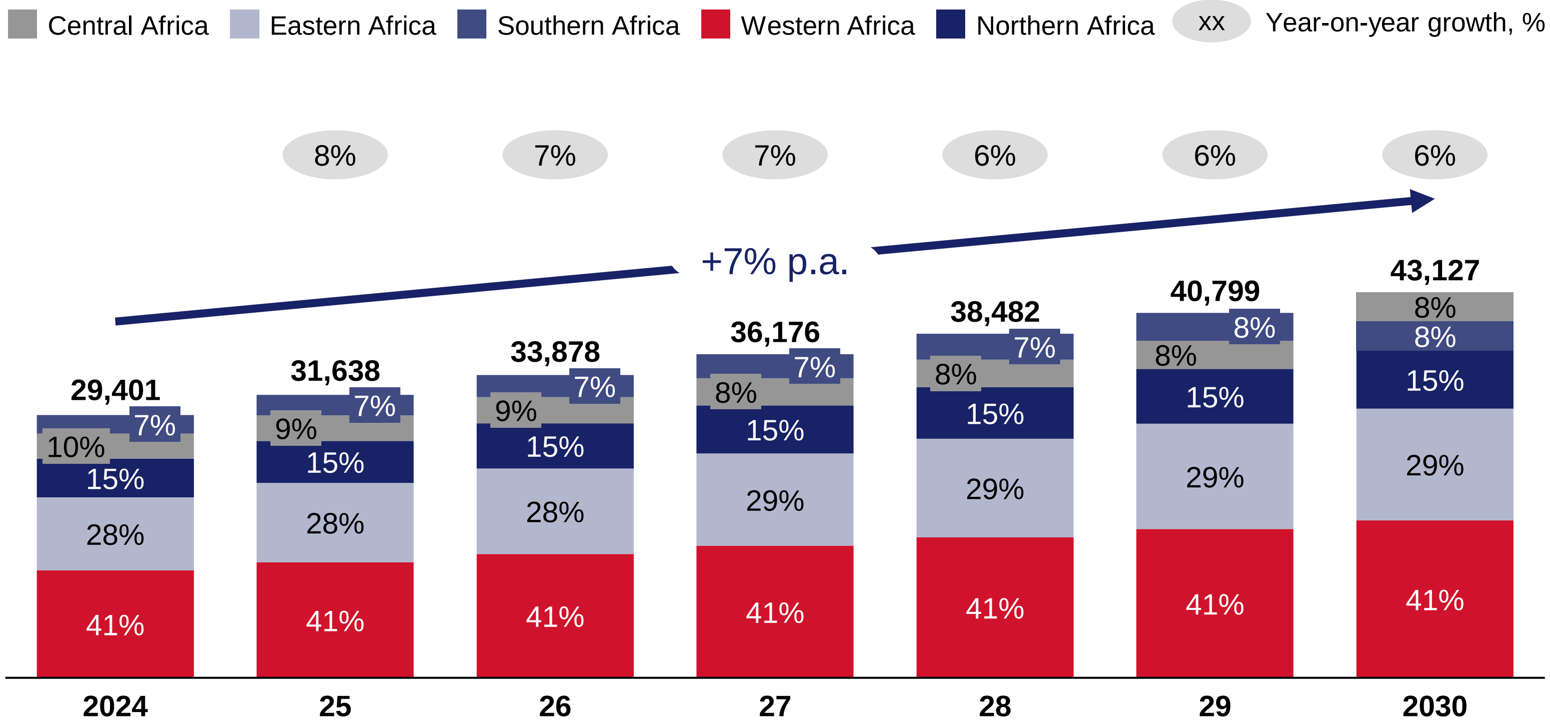
Expected two/three-wheelers fleet evolution in Africa[1], 2024-30, thousands of motorcycles



The **historical growth** (CAGR 2024-2030) of the **African two-/three- wheeler fleet** is **~5%**

Key insights and drivers of growth

- Motorcycles are a **preferred mode of transportation** in many African countries due to their **affordability** and **efficiency** in navigating **congested urban areas**
- **Rapid urbanisation** and **population growth** have spurred an increased demand for motorcycles, especially for commercial purposes, further accelerated by the rise of **digital platforms** connecting customers with motorcycle taxi services
- An inadequate **public transportation infrastructure** and **limited access to credit** have fueled the growth of the motorcycle market also for private purposes, as motorcycles offer a **more reliable** and **affordable** alternative for **daily commuting**
- **Economic growth** and **rising disposable incomes** in many African countries have enhanced **consumers' purchasing power**, enabling more people to afford **motorcycles**

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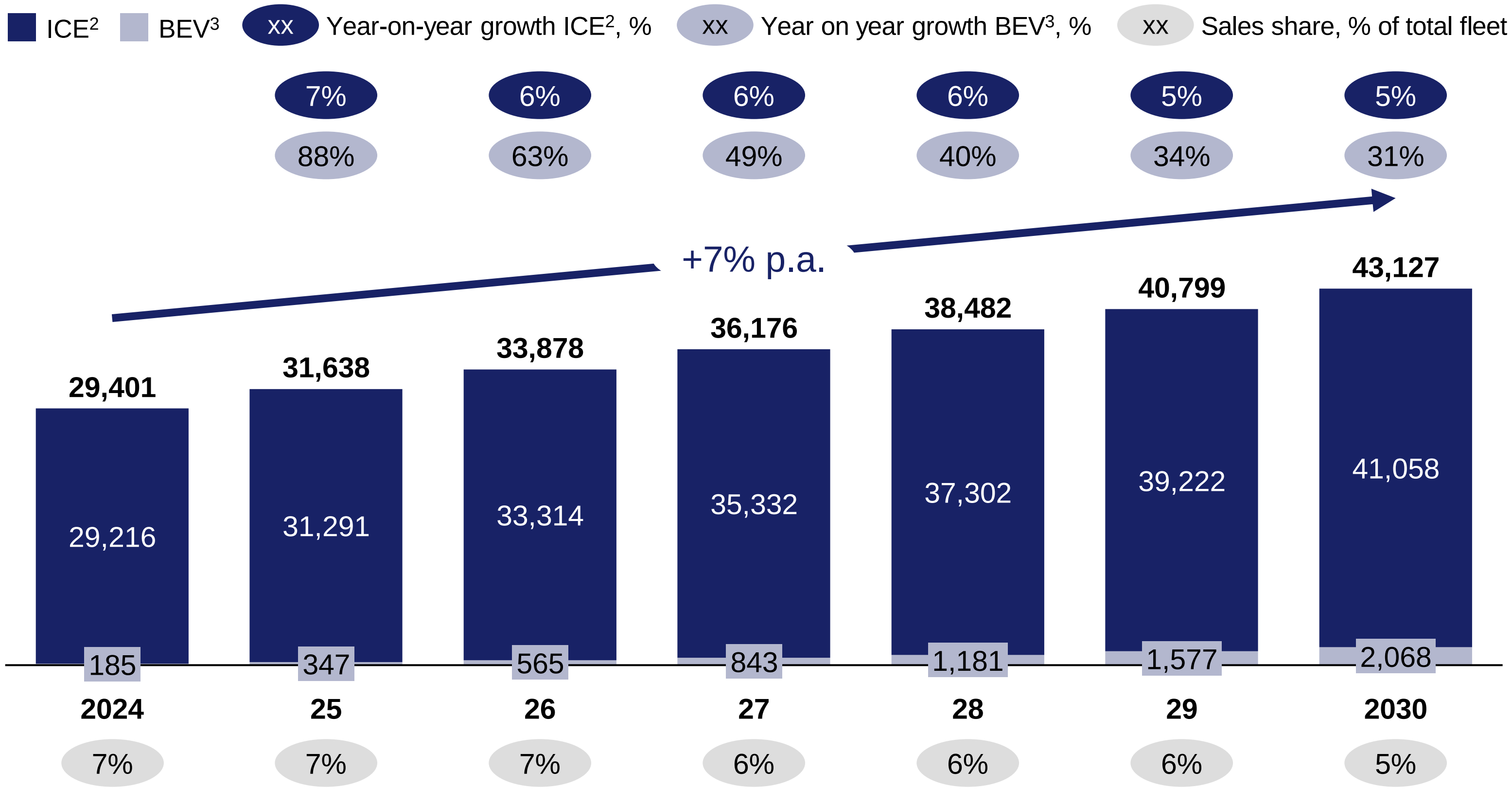
1. Countries excluded from the analysis due to unavailability of data (~5% of the African total fleet parc in 2020, ~7% of African population): Cape Verde, Central African Republic, Comoros, DRC, Djibouti, Eritrea, Eswatini, Guinea-Bissau, Liberia, Libya, Mali, Mauritania, São Tomé and Príncipe, Somalia, South Sudan

Source: FIA foundation, Statista, Expert interviews

Rising fuel prices and increasing environmental concerns will drive a shift from combustion engine motorcycles to electric motorcycles in the coming years

AS OF JULY 2024 **FLEET EVOLUTION PROJECTIONS MODELLED WITH ASSUMPTIONS DETAILED IN THE FOLLOWING PAGES**

Expected two/three-wheelers fleet evolution in Africa[1] by technology, 2024-30, thousands of motorcycles



Key insights and drivers of growth

- **Rising fuel prices** and **increasing environmental concerns** are prompting customers to prioritise motorcycles with **better fuel efficiency** or to shift to **electric solutions**
- African governments (e.g., Kenya) are actively promoting the transition from **ICE**[2] to **BEV**[3] by introducing **significant incentives** like duty-free imports of EV parts and reduced taxes on assembled EVs, creating a **favorable landscape for electric mobility**
- Improvements in **battery technology**, combined with **lower operating** and **maintenance costs** compared to **ICE**[2] **motorcycles,** are making electric motorcycles more efficient, affordable, and **attractive to consumers**

1. 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; 2. Internal Combustion Engine; 3. Battery electric vehicle

Source: FIA foundation, Statista, Expert interviews

Nigeria, Kenya, and Egypt have the highest expected electric 2/3W parc by 2030

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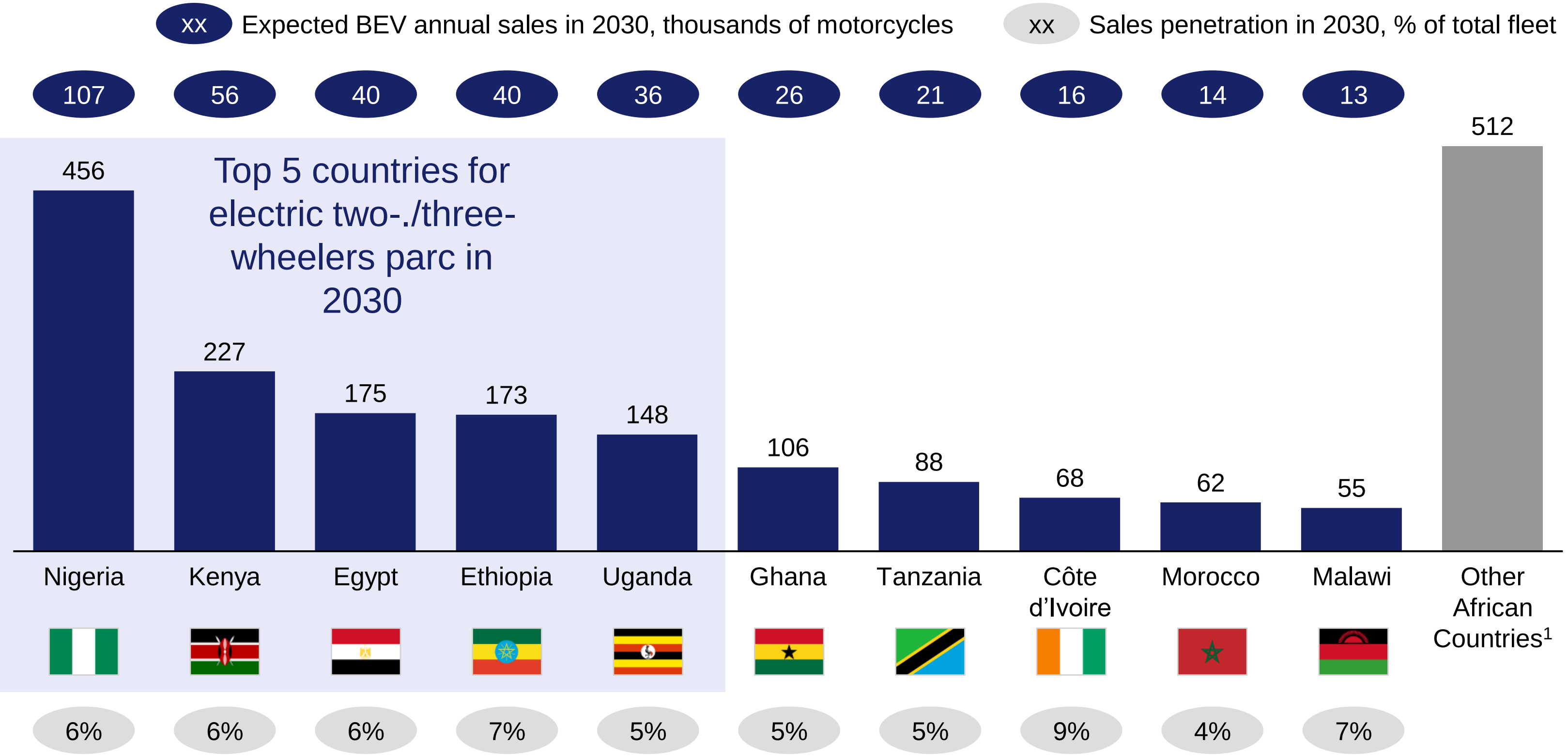
Approach for modelling the two-/here wheeler market

- We started by using **historical data** (source: FIA Foundation) to estimate the **number of motorcycles** present in Africa[1] in **2020**
- We projected the **total number of motorcycles in 2030** by estimating the **expected annual sales of motorcycles** (both ICE and BEV – source: Statista) in the coming years, and accounted for the motorcycles that would be retired each year
- We determined the proportion of future sales that would be ICE vs. BEV by developing **3 different EV adoption curves** (source: experts' interviews), these curves were allocated to each African country based on their trends in **fuel prices** (source: Global Petrol prices) and **the countries' EV regulatory activities** (source: web research), identified as the main driver of EV adoption

Expected electric two/three-wheelers parc in 2030 for top 10 African countries, 000 of motorcycles



	Nigeria	Kenya	Egypt	Ethiopia	Uganda	Ghana	Tanzania	Côte d'Ivoire	Morocco	Malawi	Other African Countries[1]
Expected BEV annual sales in 2030, thousands of motorcycles	107	56	40	40	36	26	21	16	14	13	
Parc in 2030, 000 of motorcycles	456	227	175	173	148	106	88	68	62	55	512
Sales penetration in 2030, % of total fleet	6%	6%	6%	7%	5%	5%	5%	9%	4%	7%	

Rwanda, besides its **high EV adoption curve** driven by **active EV regulatory measures** and **incentives**, is expected to reach an electric two/three-wheelers fleet of **~30k only in 2030** due to its **historical smaller fleet size** compared to **other countries**

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Source: FIA foundation, Statista, Expert interviews

In 2030, yearly demand for electric two-/three-wheeler batteries is expected to reach ~2.6 to ~3.1 GWh depending on technology adoption

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Electric two/three-wheelers' expected battery demand for top 10 African countries by scenario[1], 2030, GWh

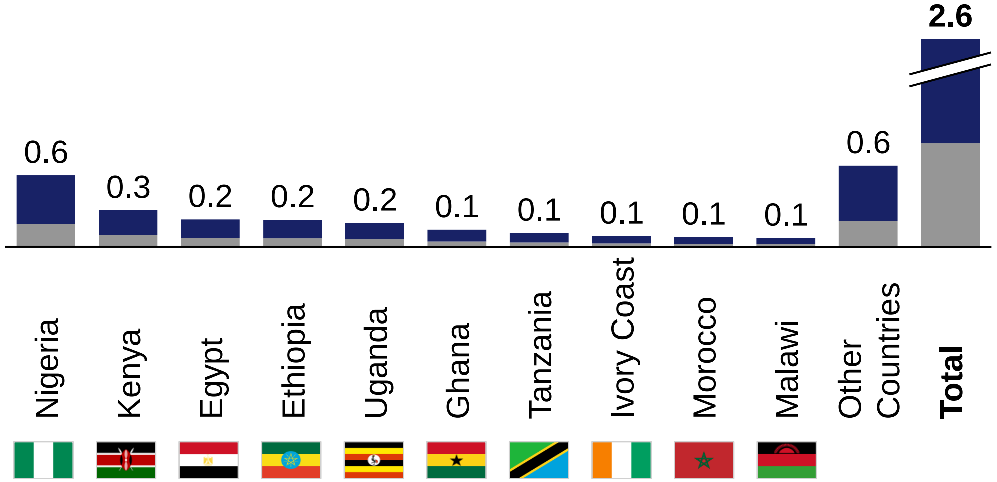
■ e2-3W Swap
■ e2-3W Charge

Technology adoption assumption

Expected battery demand, GWh

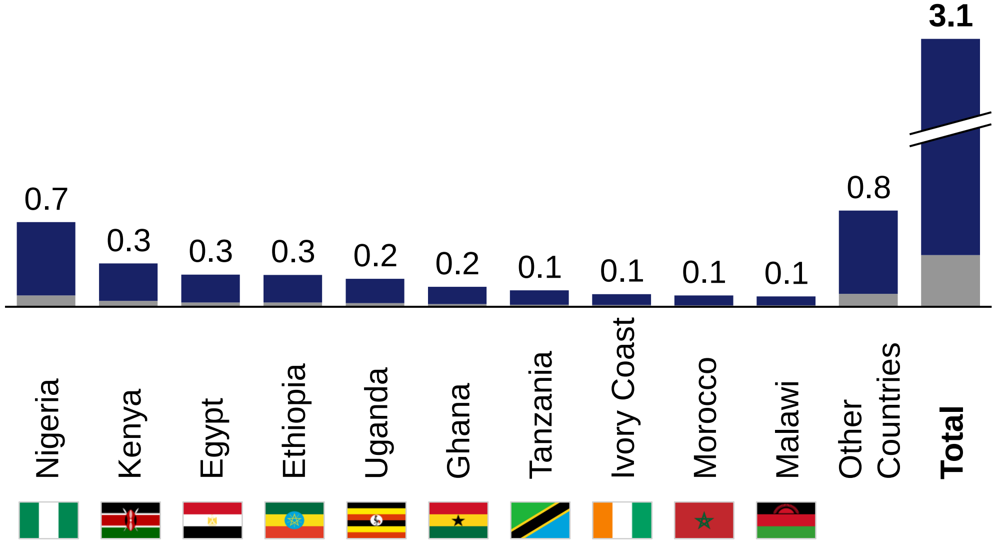
Conservative scenario

Assumed **50%** adoption of **battery SWAP** and **50%** adoption of **battery charge** from 2024 to 2030



Aggressive scenario

Assumed **75%** adoption of **battery SWAP** and **25%** adoption of **battery charge** from 2024 to 2030



The **expected demand** for **electric two/three-wheelers** battery cell production in Africa by 2030 could only justify the construction of a **giga-factory** (average full-scale production line estimated to be 2-4 GWh) under the assumption that the entire African demand would be met by production within Africa, which is unlikely – *analysis on cost competitiveness needed to understand the economic feasibility*

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Source: FIA foundation, Statista, Expert interviews

With Western and Eastern Africa will account for more than 70% of the expected battery demand in 2030

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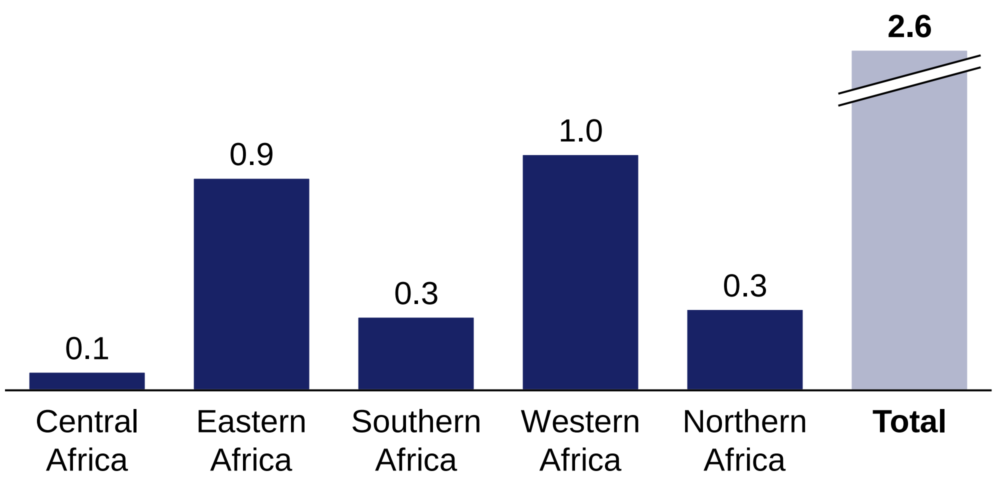
Electric two/three-wheelers expected battery demand by region by scenario[1], 2030, GWh

Technology adoption assumption

Expected battery demand, GWh

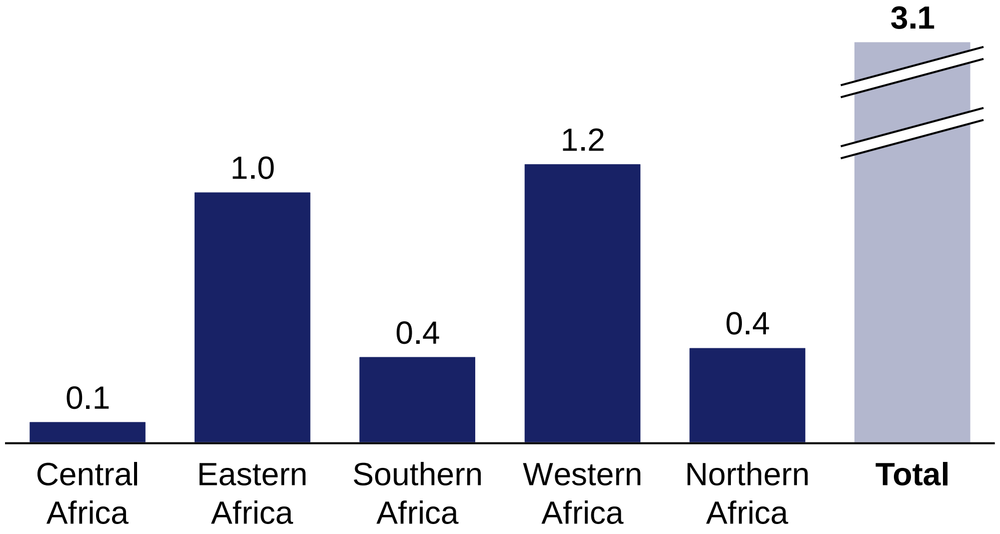
Conservative scenario

Assumed **50%** adoption of **battery SWAP** and **50%** adoption of **battery charge** from 2024 to 2030



Aggressive scenario

Assumed **75%** adoption of **battery SWAP** and **25%** adoption of **battery charge** from 2024 to 2030



The **expected demand** for **electric two/three-wheelers** battery cell production in Africa by 2030 could only justify the construction of a **giga-factory** (average full-scale production line estimated to be 2-4 GWh) under the assumption that the entire African demand would be met by production within Africa, which is unlikely – *analysis on cost competitiveness needed to understand the economic feasibility*

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Source: FIA foundation, Statista, Expert interviews

Electric two-/three-wheeler battery demand sizing - detailed methodology and assumptions (1/2)

Market sizing steps	Methodology	Detailed assumptions	Limitations	Sources leveraged
Sizing of historical two/three-wheelers fleet in 2020	Sized the **2020 two/three-wheelers fleet** from all the **54 African countries** by leveraging historical data *(~24.6 mn motorcycles in Africa in 2020)*	For North-Saharan African countries (Algeria, Egypt, Libya, Morocco, Tunisia), due to unavailability of data, the historical fleet sizes were estimated by deriving the average number of motorcycles per person from Sub-Saharan African countries and re-proportionating these figures according to each country's population Assumed that in 2020 all motorcycles in the fleets of African countries were ICE	Historical data on fleet size in 2020 not available for North-Saharan African countries (Algeria, Egypt, Libya, Morocco, Tunisia)	FIA Foundation Expert interviews
Estimation of two/three-wheelers fleet size in 2030	Derived the **expected annual sales of motorcycles** (both ICE and BEV) from 2021 to 2030 by leveraging estimations from Statista, which are based on a **selection of different forecasting techniques** tailored to the behaviour of the specific market, considering **main drivers** such as **GDP per capita**, **consumer price index**, **consumer spending**, **population** and **macroeconomic factors** *(~2.3 mn motorcycle sales in Africa – for countries in scope[1] – in 2030)*	Due to unavailability of projections after 2028, the sales annual growth rate for 2029 and 2030 is assumed the same as in 2028 Considered sales for on-road motorcycles, off-road motorcycles, and scooters (excluding models under 50cc category) Average motorcycle useful life of 10 years Due to unavailability of historical data before 2020 for most of African countries, assumed the historical two/three-wheelers fleet in 2020 as the same for the previous years (2010-2020) For countries with very aggressive estimations (e.g., Ethiopia), numbers have been adjusted with expert input	Future sales projections available only until 2028 Future sales projections not available for 15 countries, which accounted for ~5% of the historical two/three-wheelers' fleet in 2020 and ~7% of African population in 2020[2]	Statista Expert interviews

1. Average number of motorcycle per person for all the Sub-Saharan African countries is in line with the Average number of motorcycle per person for top 15 Sub-Saharan African countries for population;
2. Countries excluded from the analysis are: Cape Verde, Central African Republic, Comoros, DRC, Djibouti, Eritrea, Eswatini, Guinea-Bissau, Liberia, Libya, Mali, Mauritania, São Tomé and Príncipe, Somalia, South Sudan

Electric two-/three-wheelers' battery demand sizing detailed methodology and assumptions (2/2)

Market sizing steps	Methodology	Detailed assumptions	Limitations	Sources leveraged
Development of EV adoption curves	Development of **3 different EV adoption curves** from **2023** to **2030** to allocated the **size of future sales** that will be **ICE** vs. **BEV** for each country in scope	Low EV adoption curve ranges from 1% in 2023 to 10% in 2030 Medium EV adoption curve ranges from 2% in 2023 to 15% in 2030 High EV adoption curve ranges from 5% in 2023 to 40% in 2030	EV adoption curves estimation for the three clusters of countries based on Expert interviews	Expert interviews
Allocation of EV adoption curve to African countries in scope	Allocation of the **3 different EV adoption curves** to each of the African countries in scope based on: • **Trends in fuel prices** (main driver) • **Regulatory activity related to EVs**	Countries with higher fuel prices will experience a higher EV adoption curve as it becomes more beneficial to switch to EVs Countries with a favourable EV regulatory environment (e.g., duty-free import of EV parts, reduced taxes on assembled EVs) will have a higher EV adoption curve in the coming years	Fuel prices data are based on the most recent data available for 2024; no projections on future data are available Regulatory EV activities analysis is based on available data, further country-by-country analysis is needed	Global petrol prices Statista Expert interviews
Estimation of 2030 demand for E2/3W batteries in GWh	Derived the **2030 demand for E2/3W batteries** in GWh by developing 2 scenarios based on the **expected adoption of battery swap technology** vs **battery charge technology** *(~2.6 – 3.1 GWh of battery demand in 2030)*	***Conservative scenario****:* assumed 50% adoption of battery SWAP and 50% adoption of battery charge from 2024 to 2030 ***Aggressive scenario****:* assumed 75% adoption of battery SWAP and 25% adoption of battery charge from 2024 to 2030 Average battery SWAP size of 1.8 KWh and an average battery Charge size of 2.5 KWh Average of 3 battery (2 stored in the motorcycle and 1 at the SWAP station) for each E2/3W with SWAP technology Average useful life of the batteries of 5 years for both technologies	Due to the unavailability of country-by-country data, the split between swap and charge technologies has been kept constant for each country and year	Web search Expert interviews

Region assumptions for the countries in scope

Region	Countries in scope[1]
Central Africa	Burundi Cameroon Chad DRC, Dem. Rep. Equatorial Guinea Gabon
Eastern Africa	Ethiopia Kenya Madagascar Mauritius Rwanda Seychelles Sudan Tanzania Uganda
Northern Africa	Algeria Egypt Morocco Tunisia
Southern Africa	Angola Botswana Lesotho Malawi Mozambique Namibia South Africa Zambia Zimbabwe
Western Africa	Benin Burkina Faso Ivory Coast Gambia Ghana Guinea Niger Nigeria Senegal Sierra Leone Togo

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Source: African Union

We developed 3 different adoption curves for electric two-/three-wheelers

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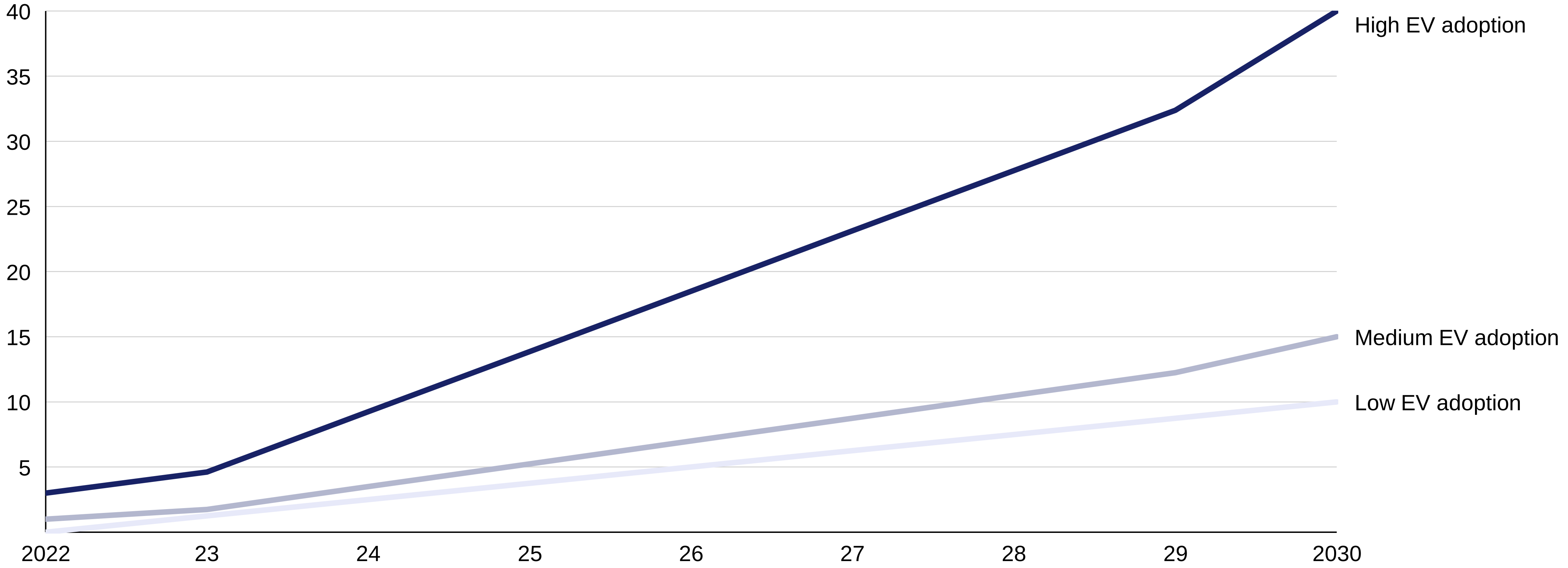
E2-3W adoption curves, % of new



Source: Expert interviews

Allocation of the EV adoption curve to African countries in scope

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● High – Price of electricity > USD 1.4 per litre
◐ Medium – Price of electricity between USD 1.4 and 1 per litre
◔ Low – Price of electricity below 1 USD per litre

Activity: ● High ◐ Medium ◔ Low

EV adoption: ■ High ▩ Medium □ Low

African countries in scope[1]	Average retail prices for gasoline, 2024, USD per liter		EV regulatory activity	Expected adoption curve for electric two-/three-wheelers
Senegal	1.64	●	◔	■
Zimbabwe	1.64	●	◔	■
Morocco	1.54	●	◐	■
Seychelles	1.53	●	◐	■
Burundi	1.52	●	◔	■
Sierra Leone	1.52	●	◔	■
Malawi	1.50	●	◔	■
Zambia	1.47	●	◔	■
Ivory Coast	1.45	●	◔	■
Mauritius	1.45	●	◔	■
Kenya	1.43	●	●	■
Uganda	1.42	●	◐	■
Burkina Faso	1.41	●	◔	■
Guinea	1.41	●	◔	■
Rwanda	1.27	◐	●	■
South Africa	1.20	◐	●	■
Gambia	1.11	◐	◐	■
Ghana	1.03	◐	◐	■
Equatorial Guinea	1.39	◐	◔	▩
Cameroon	1.39	◐	◔	▩
Ethiopia	1.37	◐	◔	▩
Mozambique	1.35	◐	◔	▩
Madagascar	1.30	◐	◔	▩
Tanzania	1.20	◐	◔	▩
DRC, Dem. Rep.	1.16	◐	◔	▩
Togo	1.16	◐	◔	▩
Benin	1.13	◐	◔	▩
Botswana	1.10	◐	◔	▩
Namibia	1.09	◐	◔	▩
Lesotho	1.06	◐	◔	▩
Tunisia	0.81	◔	◐	▩
Nigeria	0.42	◔	●	▩
Egypt	0.41	◔	◐	▩
Angola	0.36	◔	◐	▩
Algeria	0.34	◔	◐	▩
Gabon	0.99	◔	◔	□
Niger	0.91	◔	◔	□
Chad	0.85	◔	◔	□
Sudan	0.70	◔	◔	□

The EV regulatory activity KPI has been used as a secondary KPI to increase the expected electric two-/three-wheelers adoption curve in cases of medium or high regulatory impact

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Source: Statista, Global petrol prices, Expert interviews

Total annual EV sales could reach ~82,000 by 2030 in the high scenario meaning up to ~279,000 EVs on the road by 2030

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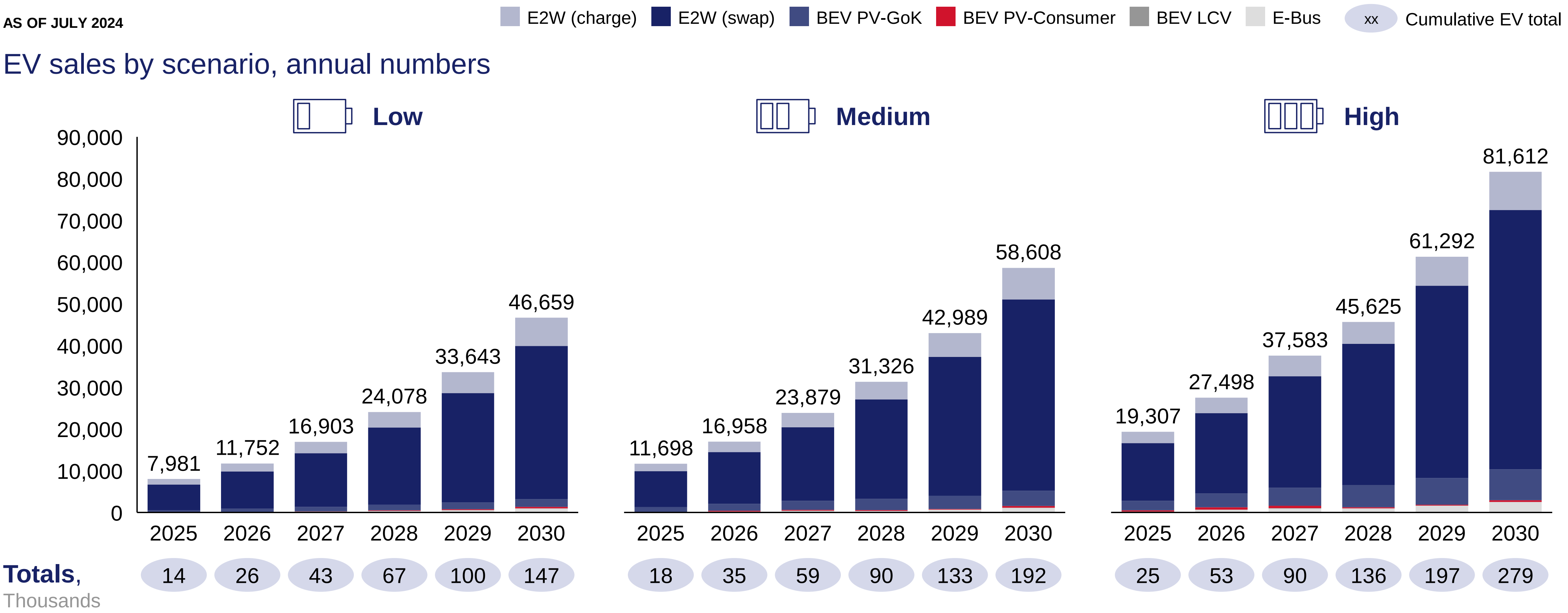

EV sales by scenario, annual numbers

By 2030, total EVs could reach between 147,000 to 279,000 (low to high scenario). The majority of this is driven by swap electric two-wheelers which account for 79% and 76% of total EV sales in the low and high scenarios respectively. A rapid increase in sales presents an opportunity to scale electric two-wheelers manufacturing in Kenya as most 2W are imported CKD.

Government procured BEV PVs is the other major contributing segment accounting for 4-9% of total EVs in the low and high scenarios. This reinforces the importance of the government as a potential early adopter of EVs

Source: FCDO EV financial model (date accessed: 29th May 2024)

BESS battery demand sizing methodology and assumptions

DETAILED ASSUMPTIONS (INCL. SOURCES) IN FOLLOWING PAGES

Market sizing steps	Methodology	Key high-level assumptions
Step 1: **Calculate the share of variable renewable energy sources (%VRES)**	**Calculated the installed solar PV[1] and wind, other[2], and total electricity capacity (MW) for 35[3] African countries** **Estimated the share of VRES** (%VRESS = Installed solar and wind electricity capacity/total installed capacity)	- Due to a lack of data (growth rate), we assumed that the wind capacity for 7[4] countries is 0. Historically, the countries have little to no wind capacity, and we assumed the trend will continue in the future
Step 2: **Define the multiplier matrix** (a matrix that shows the relationship between %VRES and %BESS (total BESS demand/total installed electricity capacity)	Linearly extrapolated the given relationship between the %BESS and %VRES (if %VRES is 15% then %BESS is ~2%, and if %VRES is 30% %BESS is ~4%) to estimate %BESS when %VRES is 5%, 10%, etc., up to 100%)	- %VRES and %BESS have a linear relationship up to when %VRES is 80%
Step 3: **Estimate the BESS demand (MWh)**	Multiply %BESS from the multiplier matrix with the total installed capacity to calculate the BESS demand in MW **Multiply the BESS demand power capacity (MW) by 3.86 hours** to estimate BESS demand energy capacity (MWh)	- 3.86 hours as the conversion factor from power capacity (MW) to energy capacity (MWh)

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1. Solar CSP is not considered within the variable renewable energy sources since it doesn’t require battery storage
2. Hydro, nuclear, coal & lignite, oil, gas, biomass & waste, tidal, and geothermal
3. 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
4. Angola, Malawi, Mozambique, Sudan, Tanzania, Uganda, Zambia

Africa’s BESS demand growth is driven by the increase in solar and wind capacity

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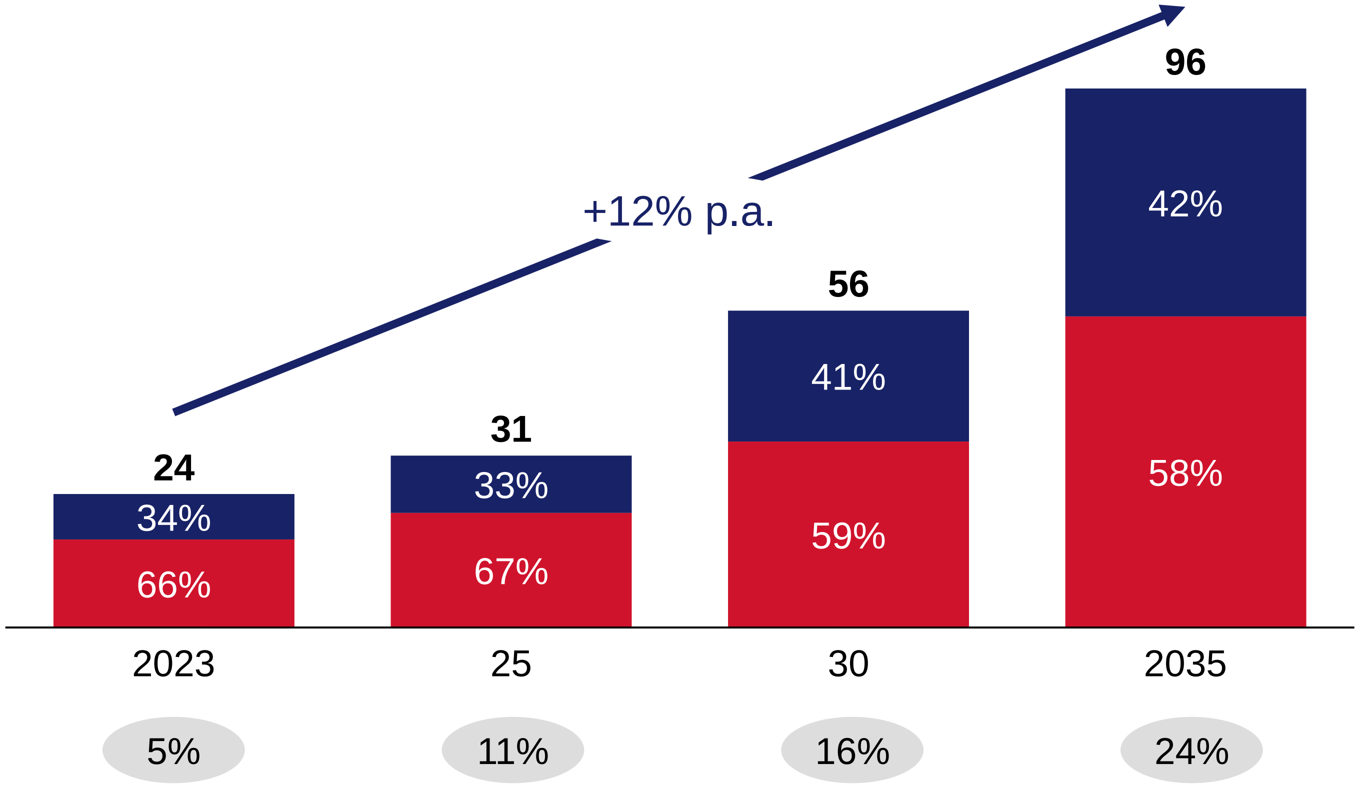
xx Share of solar and wind vs. total installed energy capacity 🟦 Wind 🟥 Solar

Africa’s[1] installed wind and solar capacity, GW



Key insights

Key drivers of renewable energy adoption in Africa are

- **Growth in electricity demand** due to population growth, rising levels of income, etc. (2020-50, the total per-capita electricity consumption could rise by 40%)
- **Continuous fall in relative prices** of renewable energy (2009-19, the price of electricity from solar and wind decreased by 89% and 70%, respectively)
- **Push by various African governments** (supportive policies, ambitious targets, support from various multilateral development organisations), e.g., Namibia targeted 70% of renewable energy in the generation mix by 2030

Growth in the installed solar and wind electricity capacity is the main driver of the BESS demand in Africa

1. 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: AFSIA, Enerdata, GlobalData, IRENA, country policies, IEA World Energy Outlook 2020, Our World in Data

In 2030, the total cumulative BESS demand in Africa could reach ~33 GWh, and the annual demand could grow to ~4 GWh

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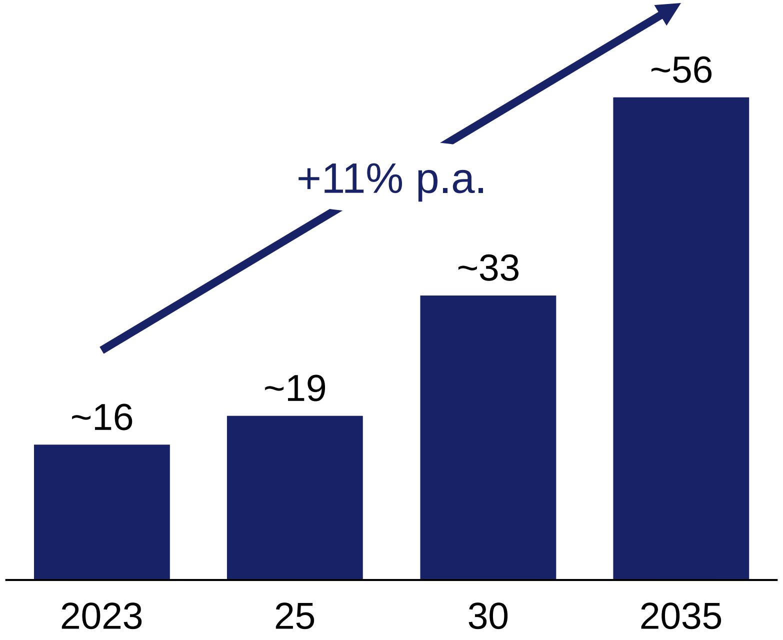
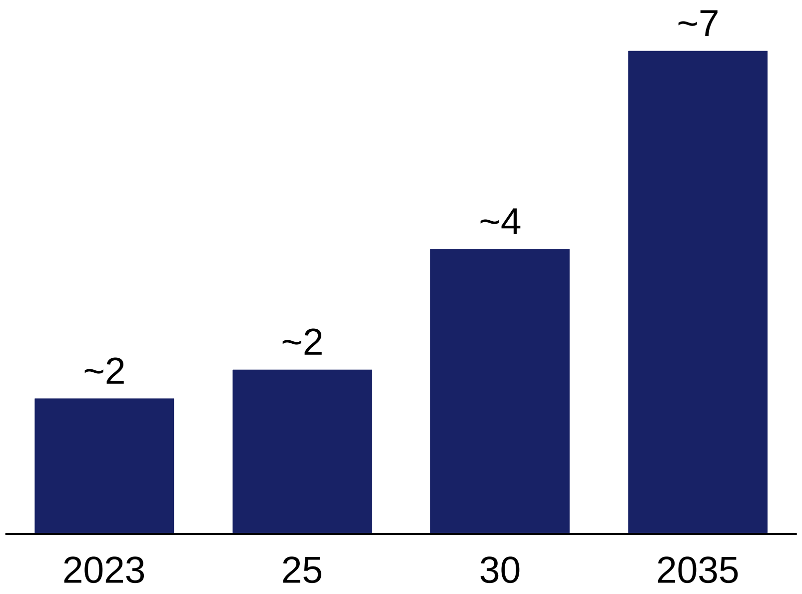
Africa's[1] total cumulative BESS demand, GWh



Africa's[1] annual BESS demand, GWh



Annual BESS demand is calculated assuming annual retirement/new demand of ~10-15%

Key insights

The annual demand of **~4 GWh in 2030 is low compared** to the typical annual **production capacity of a battery cell giga-factory** (10-15 GWh)

The ~7 GWh BESS demand in 2035 is also low compared to the demand required to set up a gigafactory since **a single Africa-based company is unlikely to capture 100% of the local market** if low-price players from China compete in the market

Africa-based players would **need to find additional demand to build a competitive gigafactory** with economies of scale

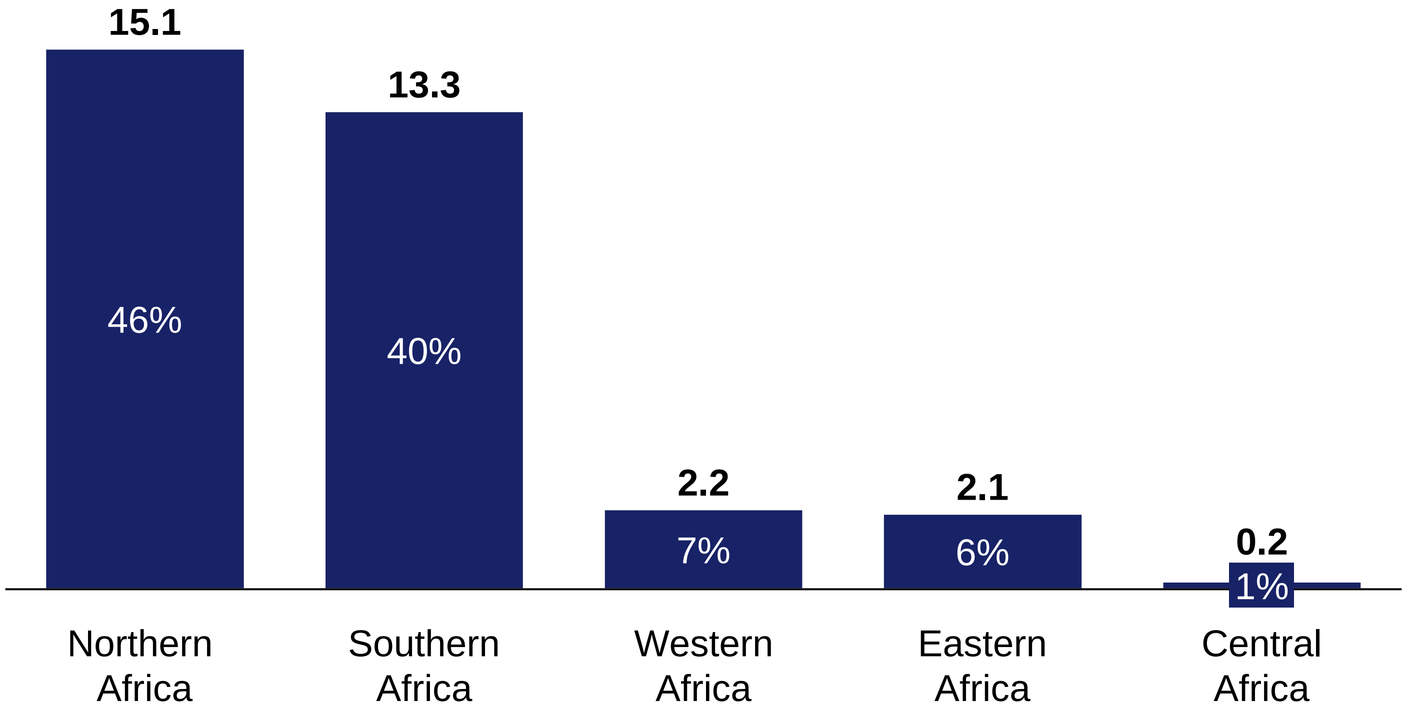
[1] Calculated only for 35 African countries (Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, DRC, Egypt, Eswatini, Ethiopia, Gabon, Ghana, Ivory Coast, Kenya, Lesotho, Libya, Malawi, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe)

Source: AFSIA, Enerdata, Global Data, USAID/Power Africa/AU-NEPAD

In Africa, BESS demand is mainly driven by Northern and Southern Africa

AS OF JULY 2024

Africa’s[1] total cumulative BESS demand by region, 2030, GWh



Key insights

The **concentrated BESS demand in Northern** and **Southern** Africa could create a **suitable environment to kick-start a BESS assembly industry** in both regions

Morocco for Northern Africa and **South Africa** for Southern Africa **could be potential assembly hubs** considering the existing battery industry and the ability to export

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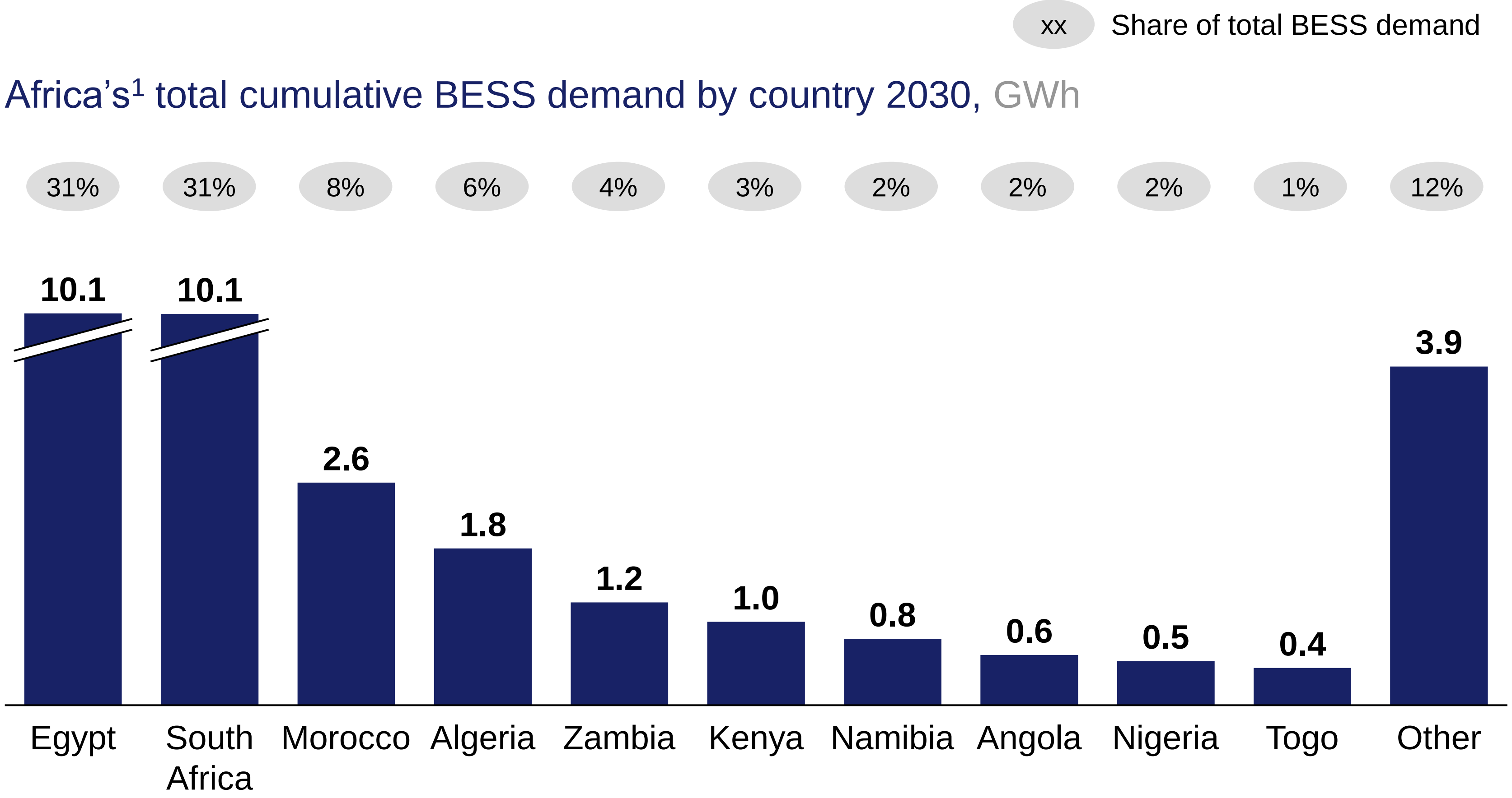
1. Calculated only for 35 African countries (Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, DRC, Egypt, Eswatini, Ethiopia, Gabon, Ghana, Ivory Coast, Kenya, Lesotho, Libya, Malawi, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe)

Source: AFSIA, Enerdata, Global Data, USAID/Power Africa/AU-NEPAD

In 2030, Egypt, South Africa, Morocco, and Algeria could account for ~75% of Africa's total cumulative BESS demand

AS OF JULY 2024

Africa's[1] total cumulative BESS demand by country 2030, GWh



Key insights

The large BESS demand in Egypt, South Africa, Morocco, and Algeria is mainly driven by the large total electricity demand and high penetration of variable renewable energy sources such solar and wind

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1. 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: AFSIA, Enerdata, Global Data, USAID/Power Africa/AU-NEPAD

BESS demand estimation approach and key assumptions (1/2)

Market sizing steps	Methodology	Key assumptions	Limitations	Sources
Calculate the share of VRES (%VRES) (share of the installed solar PV and wind electricity capacity in the total energy generation mix)	**Calculated the installed solar PV[1] and wind electricity capacity (MW)** of 35 African countries[2] (2024-30) by applying a year-on-year growth rate on historical data **Estimated the installed other electricity capacity (MW)** (hydro, nuclear, coal & lignite, oil, gas, biomass & waste, tidal, and geothermal) (2024-30) using the same approach as above **Determined the total installed electricity capacity (MW)** by adding solar PV, wind, and other **Estimated the share of variable renewable energy sources (%VRESS)** by dividing the installed solar and wind electricity capacity by the total installed capacity	Due to a lack of data (growth rate), we assumed that the wind capacity for 7[3] countries is 0. Historically, the countries have little to no wind capacity, and we assumed the trend will continue in the future	Solar and wind data available for 35 countries only	• AFSIA • Enerdata • GlobalData
Define the multiplier matrix (a matrix that shows the relationship between %VRES and %BESS (Total BESS demand/Total installed electricity capacity)	USAID report for AU-NEPAD estimated that if %VRES is 15%, then %BESS is ~2%; and if %VRES is 30%, %BESS is ~4% We linearly extrapolated the above relationship to estimate %BESS when %VRES is 5%, 10%, etc., up to 100%)	%VRES and %BESS have a linear relationship	Based on expert input, the relationship between %VRES and %BESS when %VRES is more than ~80% might not be linear. We have only 1 incidence where %VRES is 82%, making the impact of the limitation minimal	• USAID/Power Africa/ AU-NEPAD • Expert input

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1. Solar CSP is not considered within the VRES since it doesn't require battery storage
2. 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
3. Angola, Malawi, Mozambique, Sudan, Tanzania, Uganda, Zambia

BESS demand estimation approach and key assumptions (2/2)

Market sizing steps	Methodology	Key assumptions	Limitations	Sources
Estimate the BESS demand (MWh)	Multiply the %BESS from the multiplier matrix with the total installed capacity to calculate the BESS demand in MW **Multiply the BESS demand power capacity (MW) by 3.86 hours** to estimate BESS demand energy capacity (MWh)	• Based on expert input, we assumed 3.86 hours as the conversion factor from power capacity (MW) to energy capacity (MWh) • For countries that have a higher BESS demand than installed solar and wind capacity (Libya, Gabon, and DRC(2023 only)), due to data irregularities, we corrected the BESS demand to be the multiplication of the installed solar and wind capacity by the average of (BESS demand /total installed solar and wind capacity) (~22%)	The approach doesn’t consider BESS demand from other sources, such as EV charging. However, in Africa, this is very small compared to the BESS demand from solar and wind installation	• Expert input

Cost competitiveness analysis

3

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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 identified 5 main factors essential for African countries to succeed in refining raw materials

▨ Deep-dive on the next pages

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 aluminium 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

Refining cost competitiveness analysis – scope definition

✓ Raw materials included ⊗ Raw materials excluded

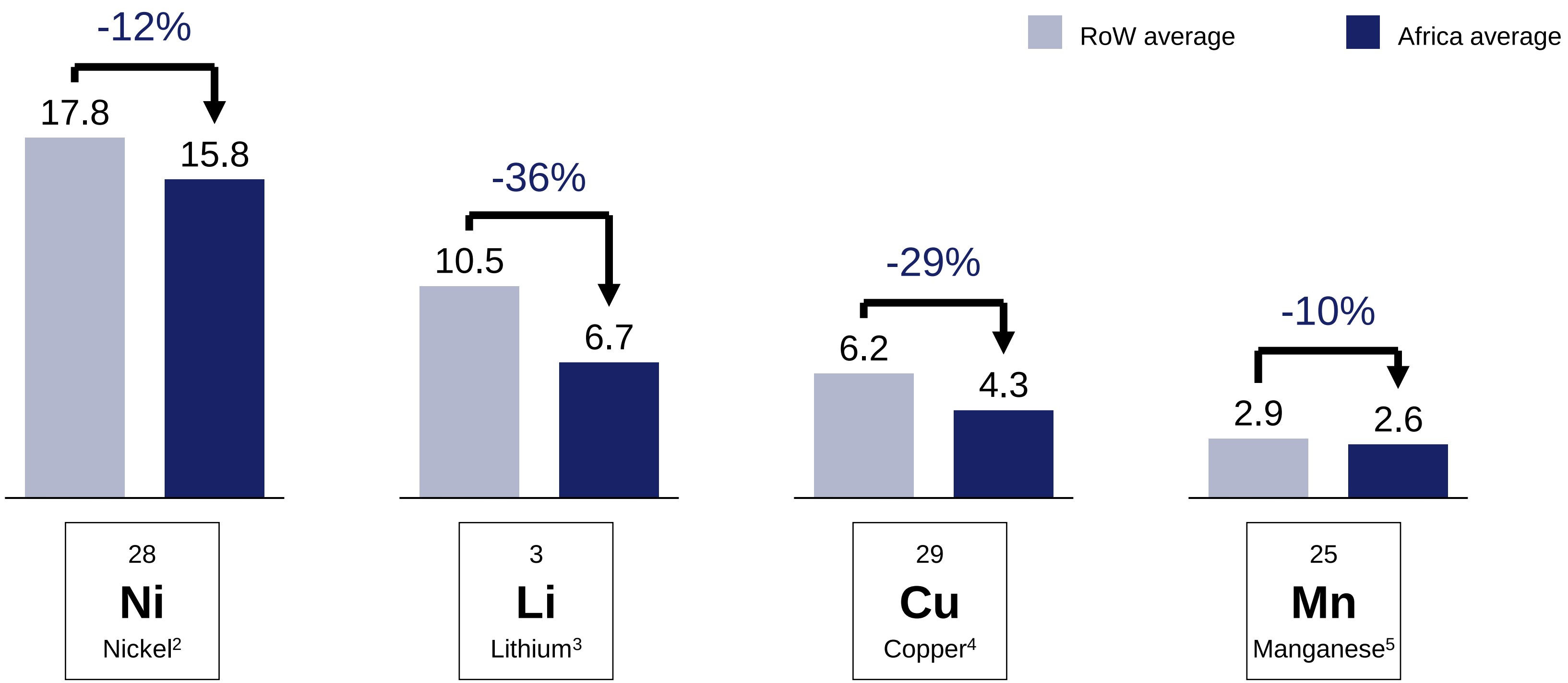
Categories	Focus of the analysis	Rationale for inclusion/exclusion
Raw materials	Key raw materials for NMC and LFP production: ✓ Lithium ✓ Nickel ✓ Manganese ✓ Copper ⊗ Cobalt ⊗ Graphite ⊗ Phosphate	✓ **Lithium:** Africa has several lithium deposits with proven operations in Zimbabwe and South Africa, and products can be transported to Western or Asian markets ✓ **Nickel:** There are numerous deposits and operational mines across the continent, with products transportable to Western or Asian markets ✓ **Manganese:** Africa is one of the largest suppliers of manganese ore, with refining projects currently planned in countries such as South Africa ✓ **Copper:** The Copperbelt region provides a significant portion of the world's mined copper supply, with operational refineries and future expansion plans ⊗ **Cobalt:** Mostly produced as a by-product of copper and nickel mining ⊗ **Graphite:** Graphite mining generally involves an initial beneficiation process carried out at the mine, achieving 95-98% purity and significantly reducing the need for further refining ⊗ **Phosphate:** Mining is primarily focused in Morocco, with refineries typically located close to LFP plants due to transportation challenges
Products	The analysis will focus on specific refined products for active materials production: • **Lithium:** lithium hydroxide • **Nickel:** nickel sulphate • **Manganese:** high purity manganese sulphate Monohydrate (HPMSM) • **Copper:** refined metal	• **Lithium:** Hydroxide is the most cost competitive option for hard rock deposits located in Africa • **Nickel:** 98% of current demand is for nickel sulphate, with nickel hydroxide having limited applications • **Manganese:** Manganese sulphate is the only relevant battery-grade product • **Copper:** Copper cathode is the only finished copper product
Time horizon	Cost competitiveness in **2030**	By focusing on **2030**, the analysis can include **countries that are currently planning** to establish their own mining supplies raw materials (e.g., lithium and nickel), while avoiding more **speculative outlooks** that could not capture all **potential early-stage projects**
Countries	Countries that have or will have 2030 mining active projects and operations • **Lithium:** DRC, Ethiopia, Ghana, Mali, Namibia, South Africa, Zimbabwe • **Copper:** Morocco, Botswana, DRC, Ivory Coast, Eritrea, Mauritania, Namibia, South Africa, Tanzania, Zambia, Zimbabwe • **Manganese:** Egypt, Morocco, Botswana, Burkina Faso, Cameroon, DRC, Ivory Coast, Gabon, Ghana, Namibia, Nigeria, South Africa, Togo, Zambia • **Nickel:** Cameroon, Ivory Coast, Madagascar, South Africa, Tanzania, Zambia, Zimbabwe	Due to the longer setup period of **5-8 years** for **mining projects**, our **2030 outlook** focuses exclusively on countries that currently have or will have **active mining projects** and **operations by that time**

Source: McKinsey MineSpans, Expert interviews

African countries can be competitive in refining raw materials compared to the RoW due to their 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]



	RoW average	Africa average	Change
Nickel[2]	17.8	15.8	-12%
Lithium[3]	10.5	6.7	-36%
Copper[4]	6.2	4.3	-29%
Manganese[5]	2.9	2.6	-10%

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

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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 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

For refining lithium, the cost-competitive advantage lies in material integration

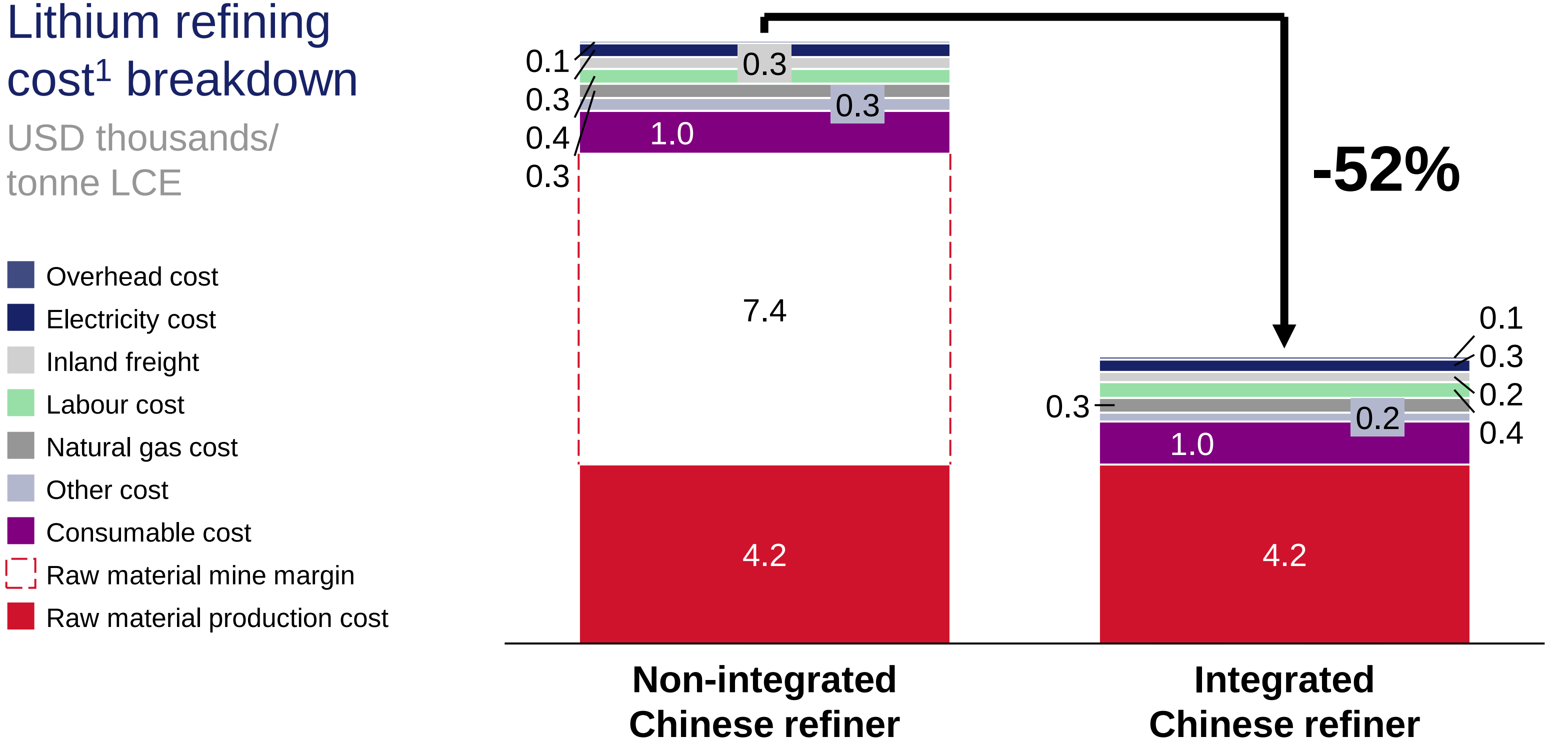
Real example for a non-integrated and an integrated Chinese refinery

AS OF JULY 2024 **OCEAN FREIGHT NOT INCLUDED IN THE ANALYSIS (ON AVERAGE, 0.5%-2% OF TOTAL COST)**

COST DISCREPANCIES ARE ALSO DUE TO MINOR DIFFERENCES IN OPERATIONAL SCALE AND EFFICIENCY OF THE ACTUAL PLANTS

Lithium refining cost[1] breakdown

USD thousands/ tonne LCE



Description	Refining players that need to secure raw materials on the open market must pay the prevailing market prices	Refining players that obtain raw materials at production cost due to partial or full ownership of the mine

Key insights

Integration with mines, providing access to **raw materials** at **production cost**, is pivotal for the **competitiveness of lithium refining plants,** contrasting with **non-integrated players** who must pay **market prices** for sourcing raw materials

By capitalizing on this **cost advantage** through integration, lithium refiners can effectively mitigate the impact of other operational expenses and **potentially operate in** historically **expensive locations**

[1] Analysis excl. ocean freight

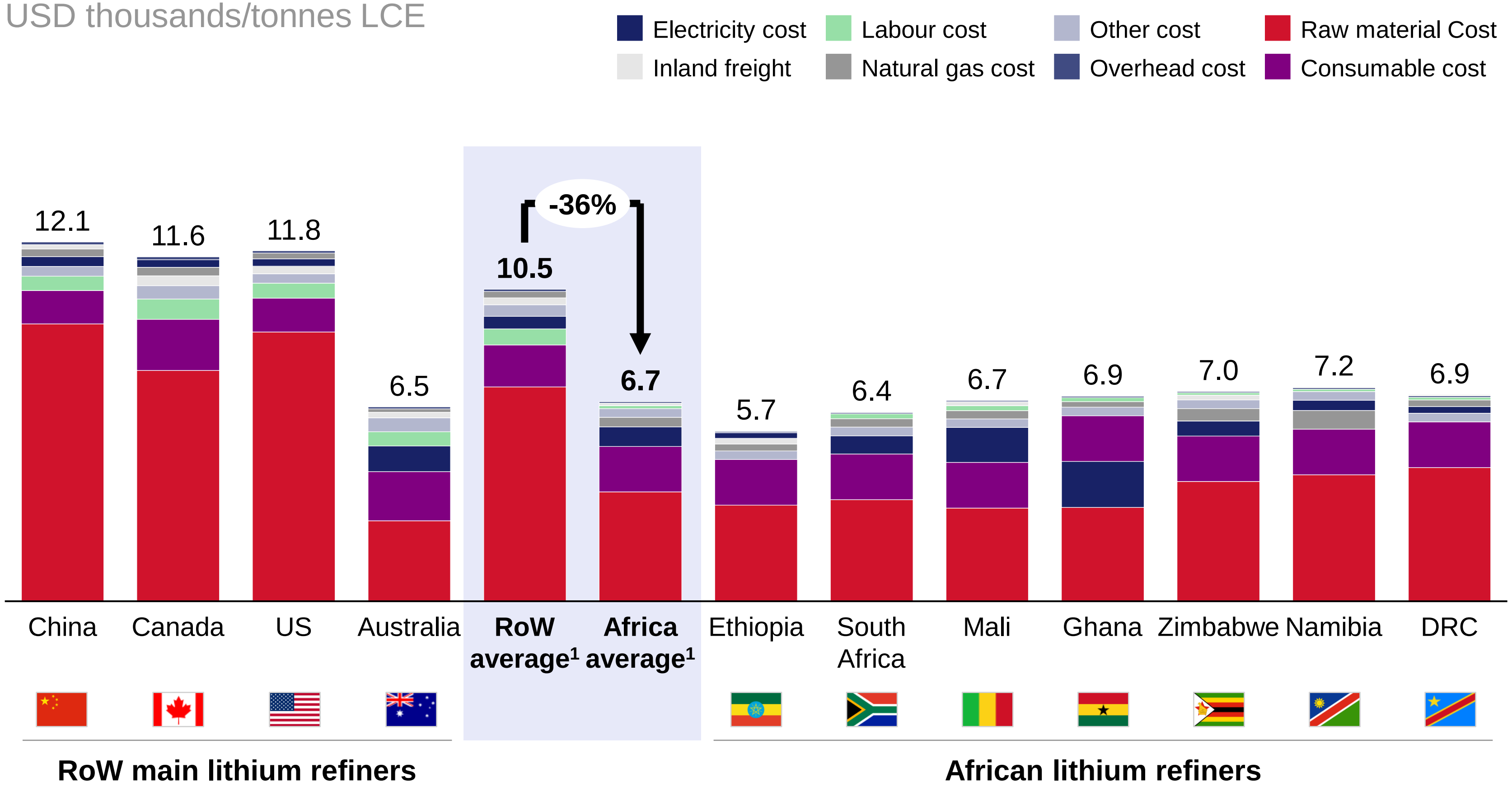
Source: McKinsey MineSpans, Expert interviews

Due to their integration with mines, African countries are on average 35-40% more competitive than refineries in the RoW

AS OF JULY 2024 **OCEAN FREIGHT NOT INCLUDED IN THE ANALYSIS (ON AVERAGE 0.5%-2% OF TOTAL COST)**

Weighted average cost breakdown for Lithium refining facilities, 2030

USD thousands/tonnes LCE



Key insights

Raw materials costs, comprising **more than half** of total refining expenses, allow **African lithium refiners** to gain a competitive edge through **raw material integration,** making them **35-40%** more competitive than the **average** RoW refineries

The **quality of lithium ore** does **not** provide a significant competitive advantage to countries, as it is **relatively uniform worldwide**

Ethiopia, with its exceptionally **low electricity costs** and **existing lithium mine,** could become one of the **most competitive** lithium refineries in the world

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1. Average of the countries considered for the analysis: Africa (DRC, Ethiopia, Ghana, Mali, Namibia, South Africa, Zimbabwe), RoW (China, Chile, US, Australia)

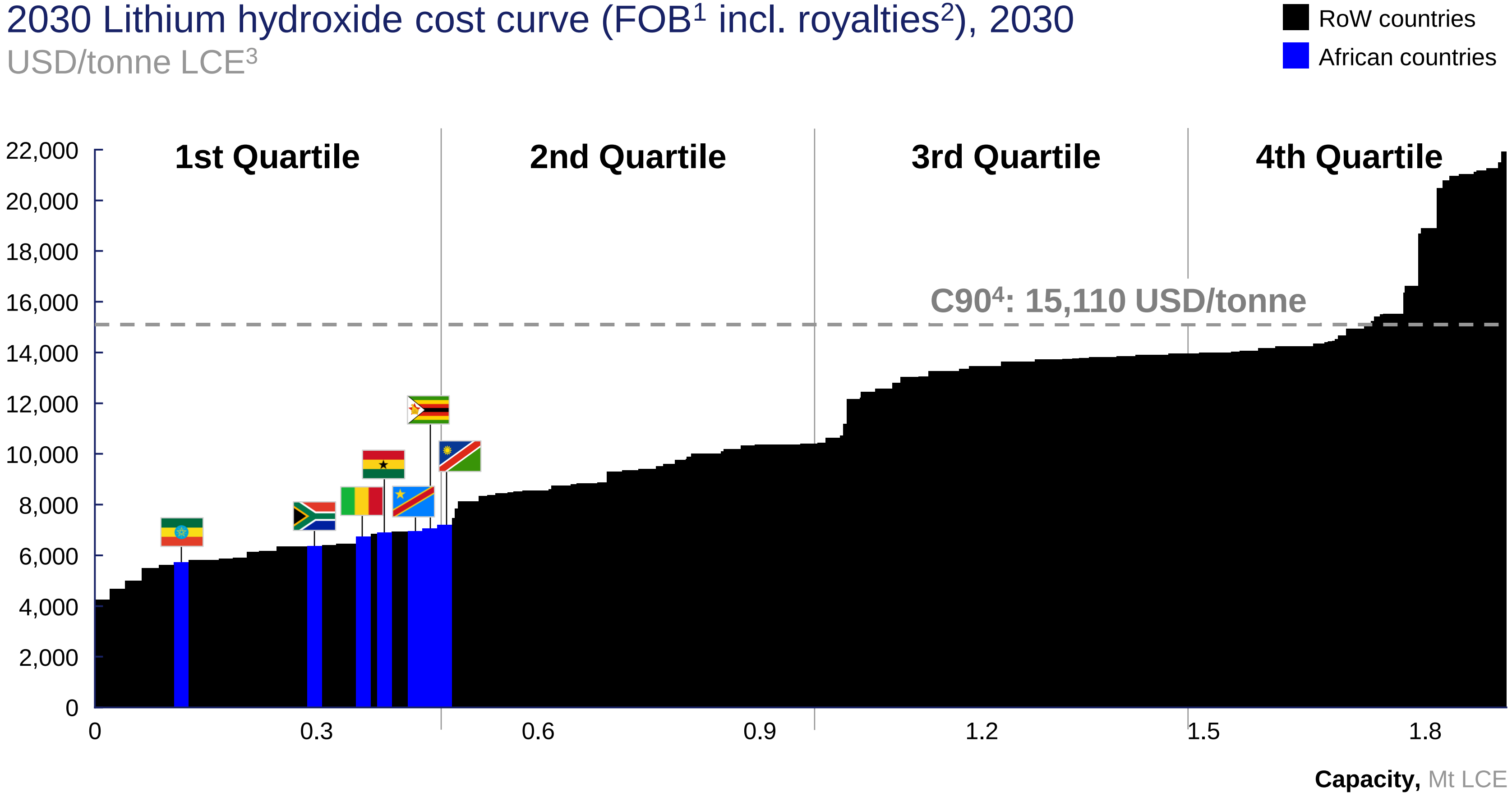
Source: McKinsey MineSpans, Expert interviews

African players can compete with non-integrated Chinese producers

AS OF JULY 2024 **OCEAN FREIGHT NOT INCLUDED IN THE ANALYSIS (ON AVERAGE, 0.5%-2% OF TOTAL COST)**

2030 Lithium hydroxide cost curve (FOB[1] incl. royalties[2]), 2030

USD/tonne LCE[3]



Key insights

1st quartile: producers with high quality lithium[5] (quantity of lithium ore) and integrated with the mines are likely to have the lowest operational costs

2nd quartile: Second quartile contains partially integrated refiners and lithium[6] producers with lower-quality deposits

3rd quartile: Chinese non-integrated players that rely on raw material coming from spot market are usually placed in third quartile of the cost curve

4th quartile: Non-integrated European and Asian producers relying on raw material coming from spot market are the most expensive producers of lithium hydroxide

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1. Free On Board – costs include delivery to port without sea freight; 2. Royalty, mining specific tax usually imposed by local governments; 3. Lithium Carbonate Equivalent; 4. 90th Percentile usually referred to as cost of marginal producers; 5. Brine and integrated spodumene; 6. Only brine producers

Source: McKinsey MineSpans

The cost-competitive advantage lies in material integration and the origin of raw materials

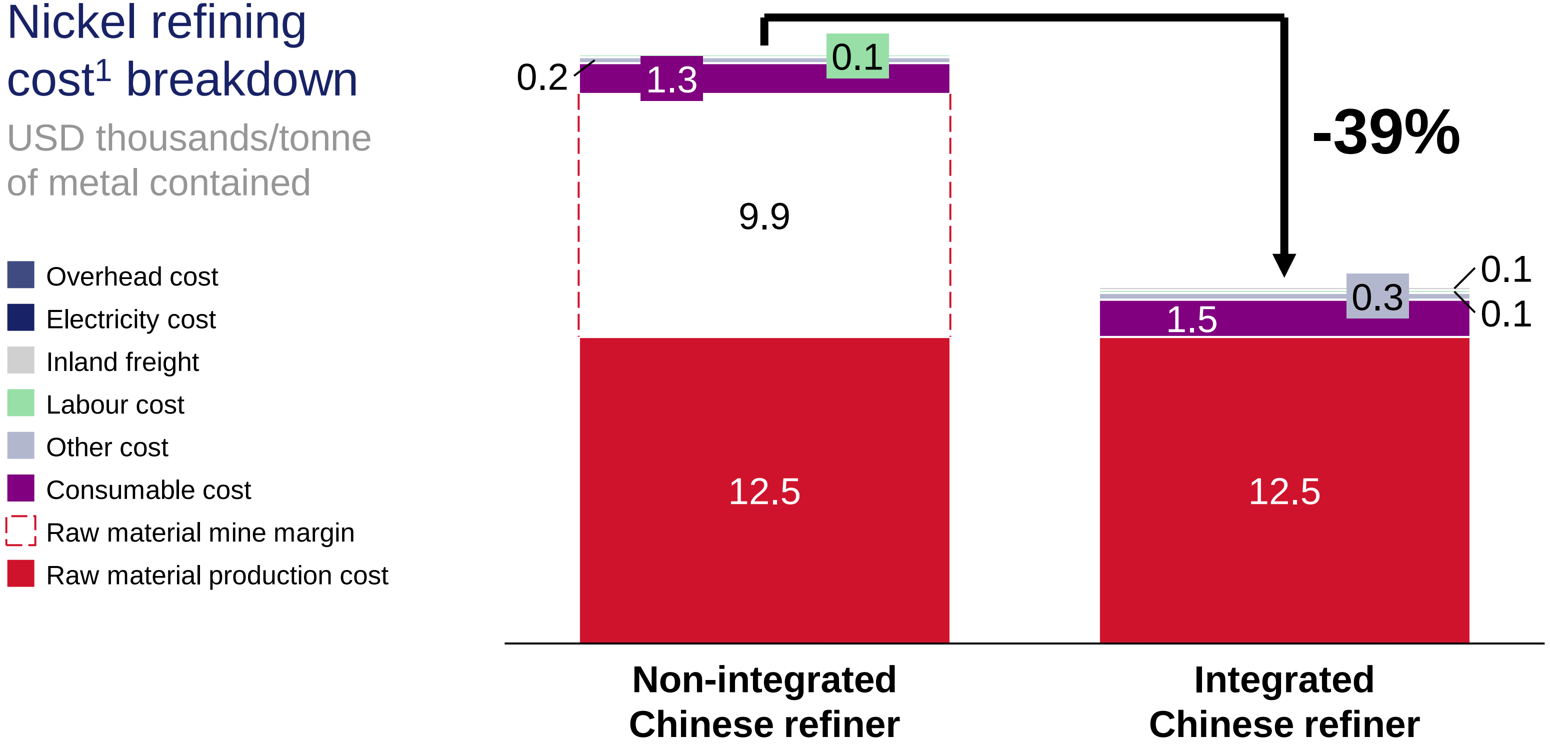
Example for a non-integrated and an integrated Chinese refinery

AS OF JULY 2024 **OCEAN FREIGHT NOT INCLUDED IN THE ANALYSIS (ON AVERAGE, 0.5%-2% OF TOTAL COST)**

COST DISCREPANCIES ARE ALSO DUE TO MINOR DIFFERENCES IN OPERATIONAL SCALE AND EFFICIENCY OF THE ACTUAL PLANTS

Nickel refining cost[1] breakdown

USD thousands/tonne of metal contained



Description	Refining players that need to secure raw materials on the open market must pay the prevailing market prices	Refining players that obtain raw materials at production cost due to partial or full ownership of the mine

Key insights

Integration with mines, providing access to **raw materials** at **production cost**, is pivotal for the **competitiveness of nickel sulphate refineries**, contrasting with **non-integrated players** who must pay **market prices** for sourcing raw materials

Securing access to **low-cost consumables** from the market (e.g., reagents for chemical processes) is essential for maintaining competitiveness in **nickel refining**

While **operational efficiency** is advantageous, it is less critical because raw materials account for more than **60-70%** of the total refining cost

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1. Analysis excl. ocean freight

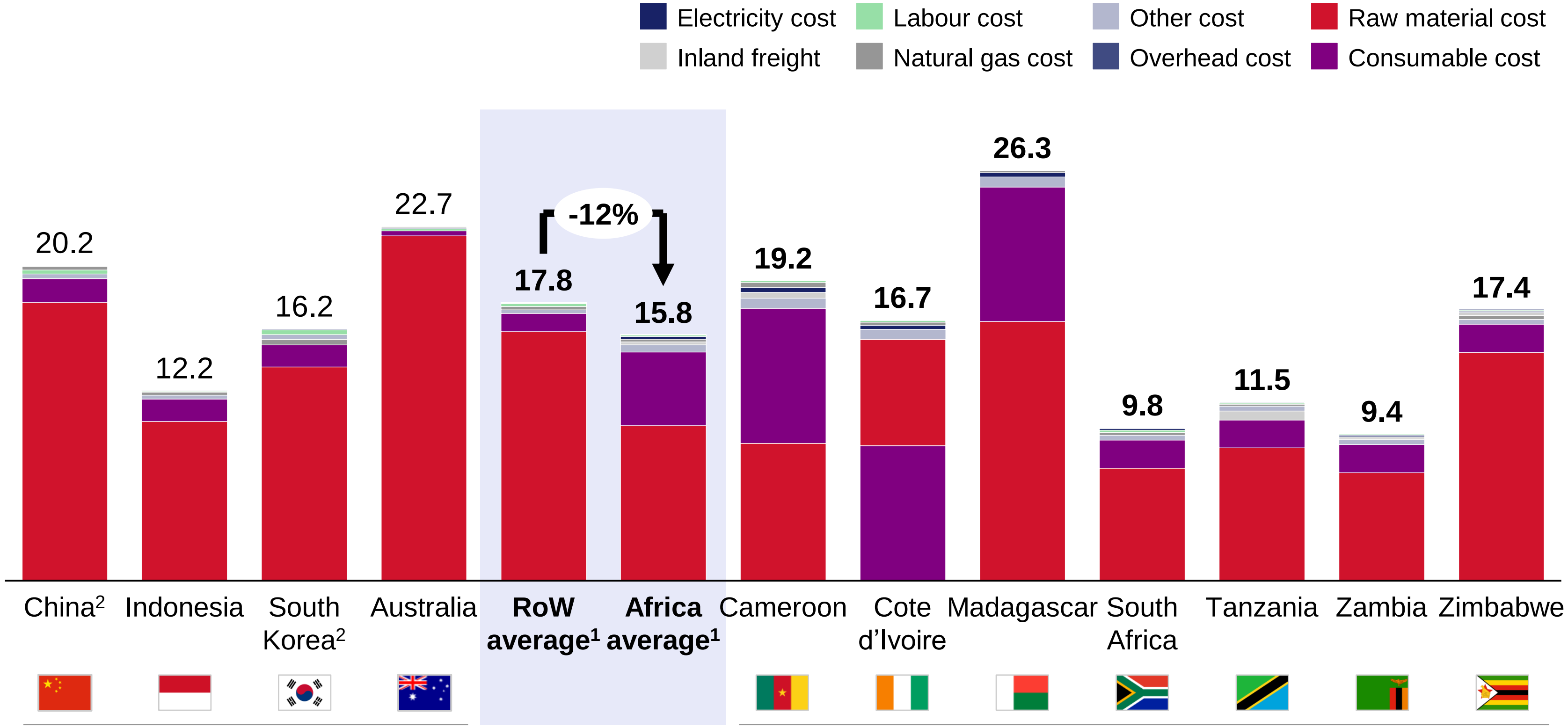
Source: McKinsey MineSpans, Expert interviews

Due to their integration with mines, African countries are on average 10-15% more competitive than refineries in the RoW

AS OF JULY 2024 **OCEAN FREIGHT NOT INCLUDED IN THE ANALYSIS (ON AVERAGE, 0.5%-2% OF TOTAL COST)**

Weighted average cost breakdown for nickel refining facilities, 2030

USD thousands/tonne of metal contained



RoW main nickel refiners **African nickel refiners**

1. Average of the countries considered for the analysis: Africa (Cameroon, Ivory Coast, Madagascar, South Africa, Tanzania, Zambia, Zimbabwe), RoW (China, Indonesia, South Korea, Australia); 2. Partial integration with mine (only part of the raw materials are sources at production price)

Source: McKinsey MineSpans, Expert interviews

Key insights

Raw materials costs, comprising **more than half** of total refining expenses, allow **African nickel refiners** to gain a competitive edge through **raw material integration** with **the mines**

Madagascar with **high raw material cost** due to **inefficiencies in mine operations** (e.g., machinery utilisation), posing challenges for **cost-effective refining**

Zimbabwe's anticipated small-scale nickel mines are likely to face **higher extraction costs,** impacting the **overall economics** of **raw material costs**

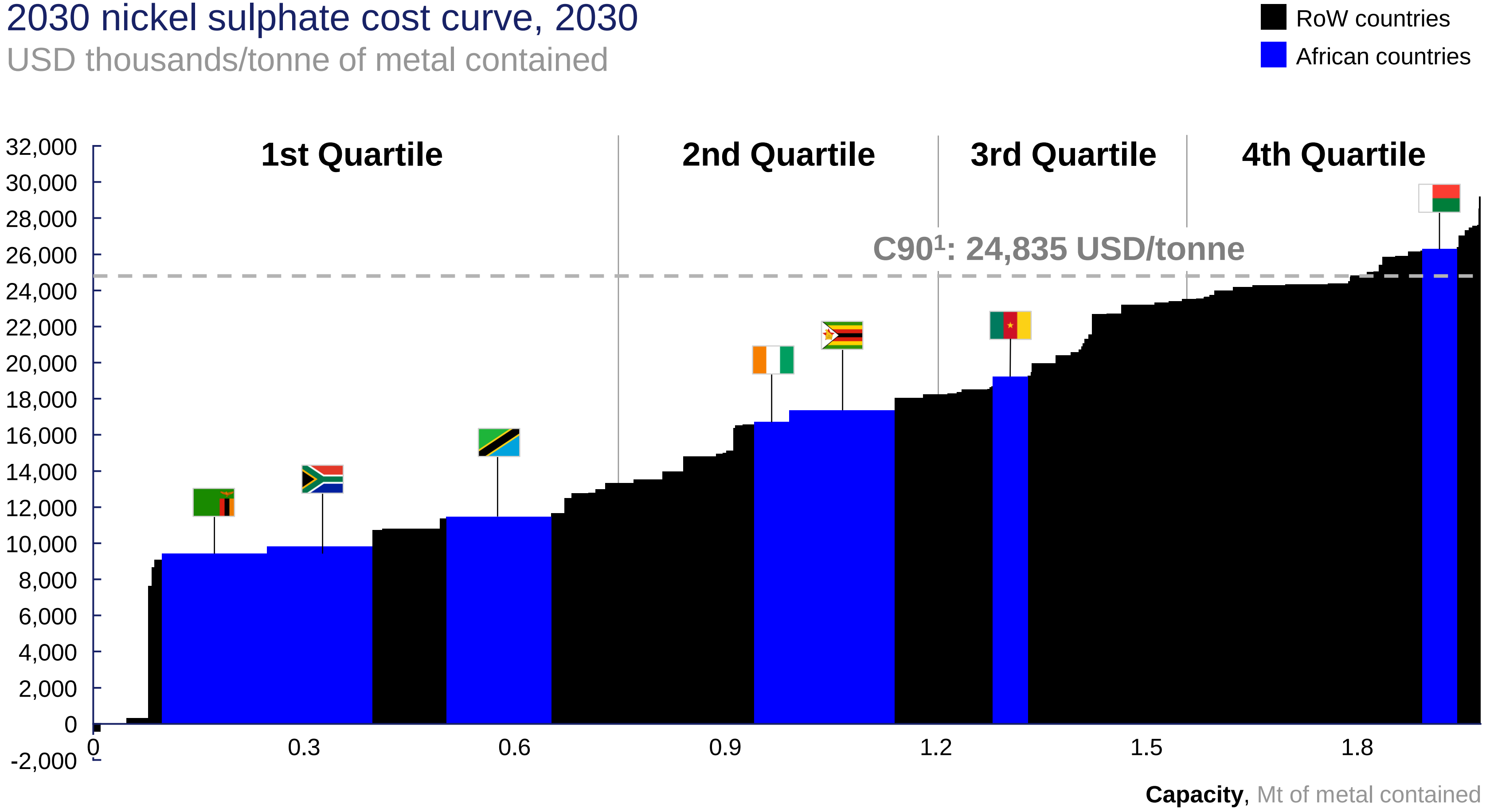
Countries like **Cameroon**, **Ivory Coast**, and **Madagascar**, with varying nickel deposit types (laterite vs. sulphide), require **specialised consumables** and **processes compared** to their counter-parts (e.g., South Africa, Tanzania, Zimbabwe, and Zambia), influencing their **cost structures**

The origin of raw materials determines the position of countries on the nickel sulphate cost curve

AS OF JULY 2024 **OCEAN FREIGHT NOT INCLUDED IN THE ANALYSIS (ON AVERAGE, 0.5%-2% OF TOTAL COST)**

2030 nickel sulphate cost curve, 2030

USD thousands/tonne of metal contained



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1. 90th percentile usually referred to as cost of marginal producers

Source: McKinsey MineSpans

Key insights

The cost of nickel sulphate is significantly influenced by the **integration with mines** and the **raw materials deposits** (influencing the cost of consumables and processes)

Operations in **some African countries** (e.g., Ambatovy mine in Madagascar) encounter obstacles in **extracting laterite ore** (inefficiencies in mine operations), raising concerns about the advantages of **integrating assets** vs. relying on **external markets**

China leads in **nickel sulphate production**, utilizing a mix of **integrated** and **non-integrated approaches** due to limited mine ownership

Labour, reagents, and energy are key factors influencing the competitiveness of manganese producers

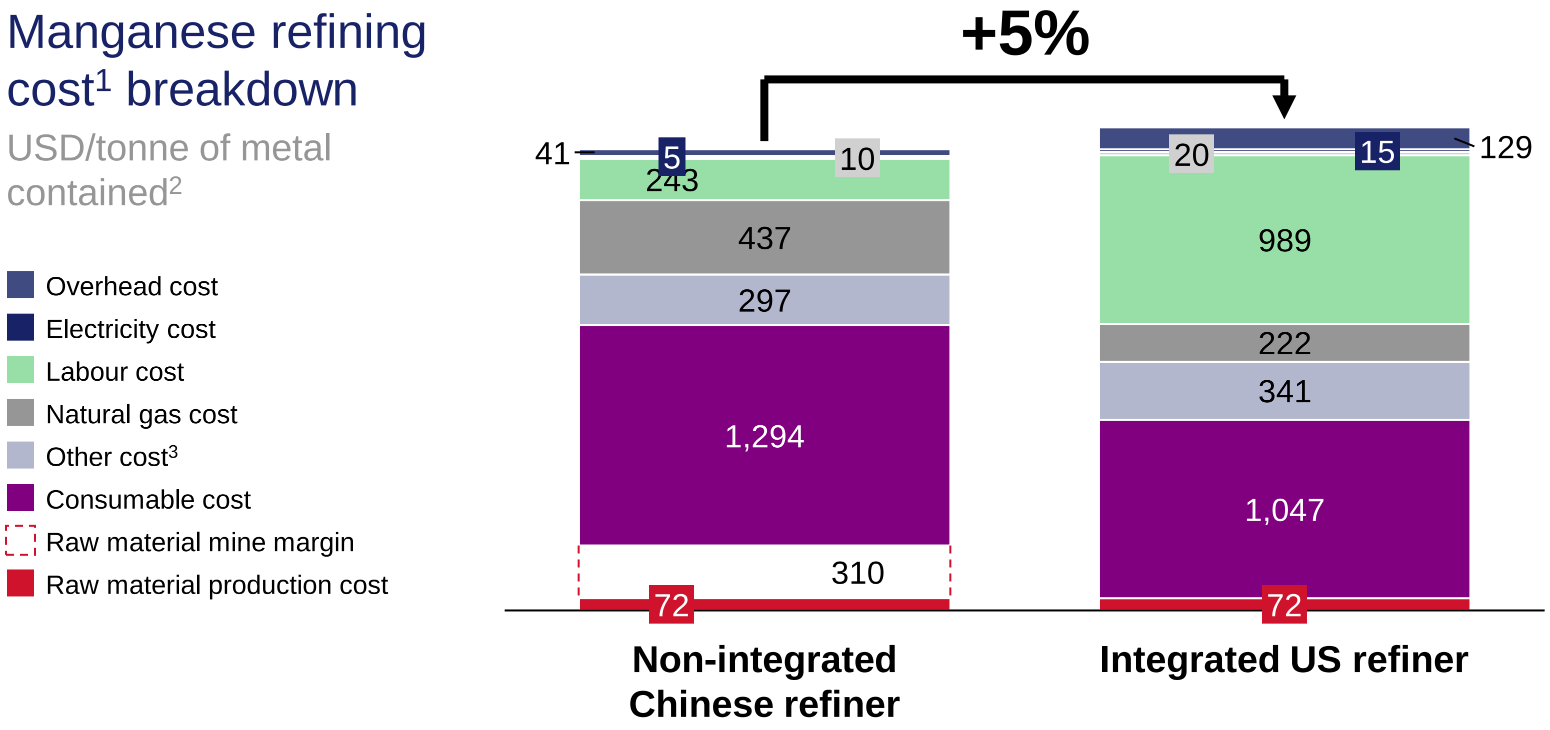
Example for a non-integrated and an integrated refinery

AS OF JULY 2024 **OCEAN FREIGHT NOT INCLUDED IN THE ANALYSIS (ON AVERAGE, 0.5%-2% OF TOTAL COST)**

COST DISCREPANCIES ARE ALSO DUE TO MINOR DIFFERENCES IN OPERATIONAL SCALE AND EFFICIENCY OF THE ACTUAL PLANTS

Manganese refining cost[1] breakdown

USD/tonne of metal contained[2]



Description	Refining players that need to secure raw materials on the open market must pay the prevailing market prices	Refining players that obtain raw materials at production cost due to partial or full ownership of the mine

Key insights

Raw material costs play a secondary role in manganese refining competitiveness, given the **vast global supply** for **manganese**, where only a small portion is dedicated to **battery production** (90%+ of the ore is dedicated to steel)

Competitiveness in **manganese refining** hinges heavily on **labour costs** due to the **labour-intensive nature of processing** nickel, and **consumable costs** (e.g., reagents) required for **intricate chemical processes**

The competitive position in manganese refining is significantly influenced by **natural gas costs**, as the process is **highly energy-intensive**, particularly in terms of **heating requirements**

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1. Analysis excl. ocean freight; 2. Metal contained in HPMSM; 3. Building maintenance, equipment maintenance (e.g., filters)

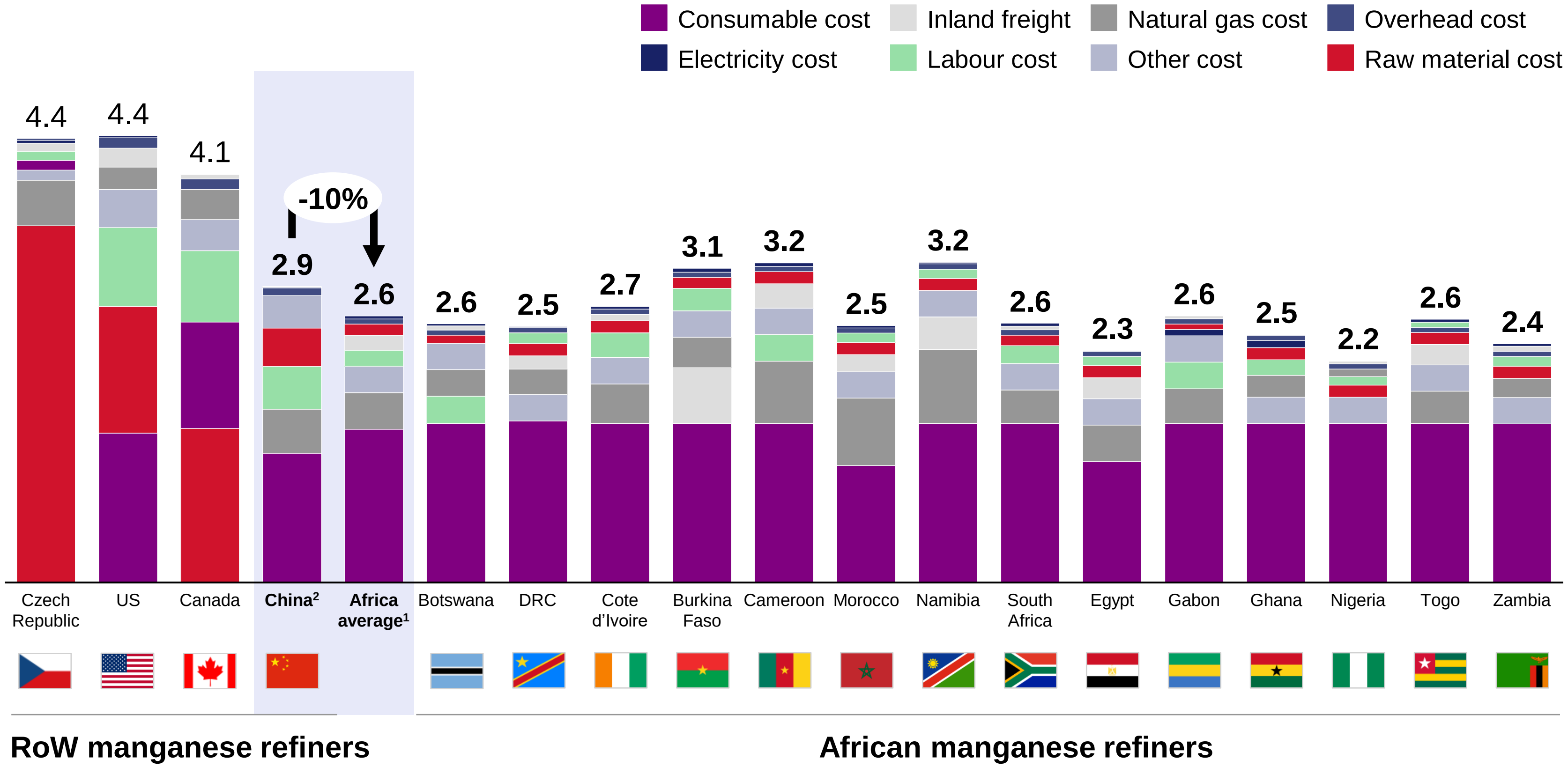
Source: McKinsey MineSpans, Expert interviews

African producers can achieve competitiveness against China, driven by their lower labour costs

AS OF JULY 2024 **OCEAN FREIGHT NOT INCLUDED IN THE ANALYSIS (ON AVERAGE 0.5% - 2% OF TOTAL COST)**

Weighted average cost breakdown for manganese refining facilities, 2030

USD/tonne of metal contained



1. Average of the countries considered for the analysis: Africa (Botswana, DRC, Cameroon, Ivory Coast, Burkina Faso, Morocco, Namibia, Egypt, Gabon, Ghana, Nigeria, Togo, Zambia); 2. Chinese players are currently not integrated

Source: McKinsey MineSpans, Expert interviews

Key insights

By 2030, China is expected to refine **60-80%** of **total global manganese**, African producers will **primarily compete** with **Chinese counterparts**

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**

Manganese projects in **North America** and **Europe** (e.g., Czech Republic) confront **viability** issues primarily stemming from **elevated raw material** and **consumable costs**, exacerbated by the use of diverse **ore types**

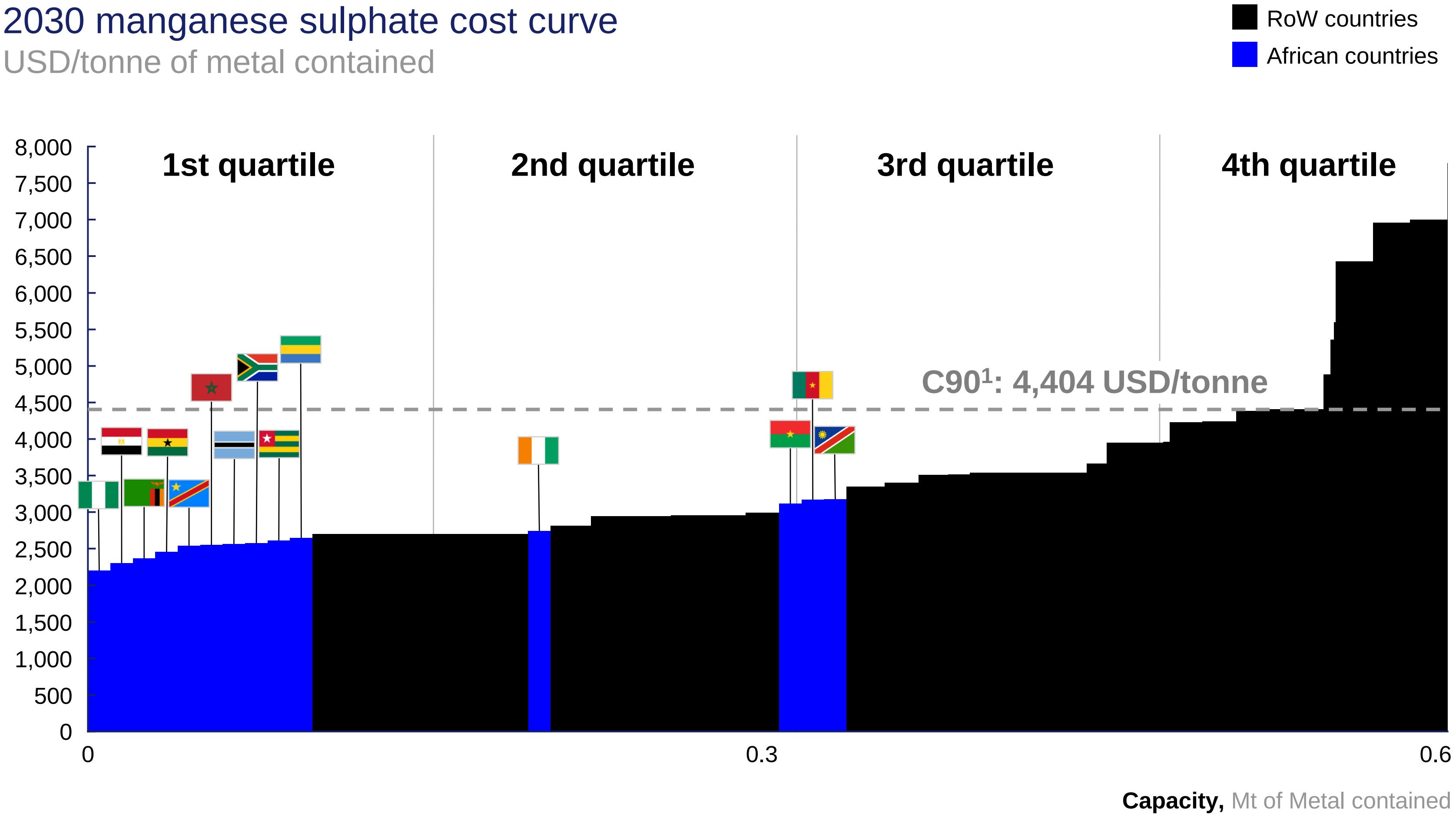
Countries lacking **robust railway infrastructure** face substantial **transportation expenses** (inland freight), particularly due to the extended distances to the **nearest ports**

African players have the potential to compete with Chinese producers

AS OF JULY 2024 **OCEAN FREIGHT NOT INCLUDED IN THE ANALYSIS (ON AVERAGE 0.5% - 2% OF TOTAL COST)**

2030 manganese sulphate cost curve

USD/tonne of metal contained



Key insights

While African countries could be well-positioned on cost curves, they face **minimal differentiation from non-integrated Chinese players:** integration by Chinese firms through acquiring African mines could present formidable challenges as they would **source manganese** at **production price**

Restricting manganese exports isn't feasible as over **95% of exports** are raw materials essential for the steel value chain

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1. 90th percentile usually referred to as cost of marginal producers;

Source: McKinsey MineSpans

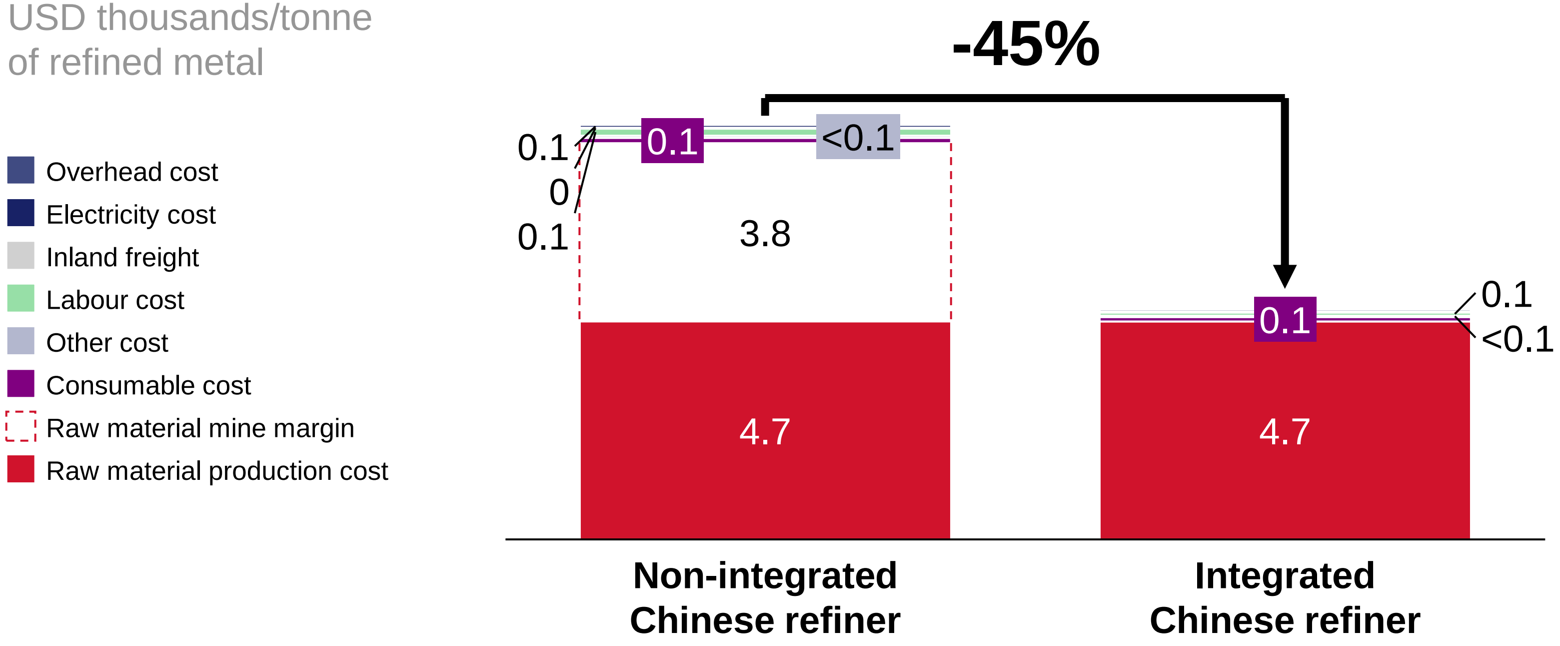
For refining copper, the cost-competitive advantage lies in material integration

Example for a non-integrated and an integrated Chinese refinery

AS OF JULY 2024 OCEAN FREIGHT NOT INCLUDED IN THE ANALYSIS (ON AVERAGE, 0.5%-2% OF TOTAL COST)

COST DISCREPANCIES ARE ALSO DUE TO MINOR DIFFERENCES IN OPERATIONAL SCALE AND EFFICIENCY OF THE ACTUAL PLANTS

Copper refining cost[1] breakdown, USD thousands/tonne of refined metal



Description	Refining players that need to secure raw materials on the open market must pay the prevailing market prices	Refining players that obtain raw materials at production cost due to partial or full ownership of the mine

Key insights

Integration with mines, providing access to **raw materials** at **production cost**, is pivotal for the **competitiveness of copper refining plants**, contrasting with **non-integrated players** who must pay **market prices** for sourcing raw materials

By capitalizing on this **cost advantage** through integration, copper refiners can effectively mitigate the impact of other operational expenses and **potentially operate in** historically **expensive locations**

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1. Analysis excl. the ocean freight

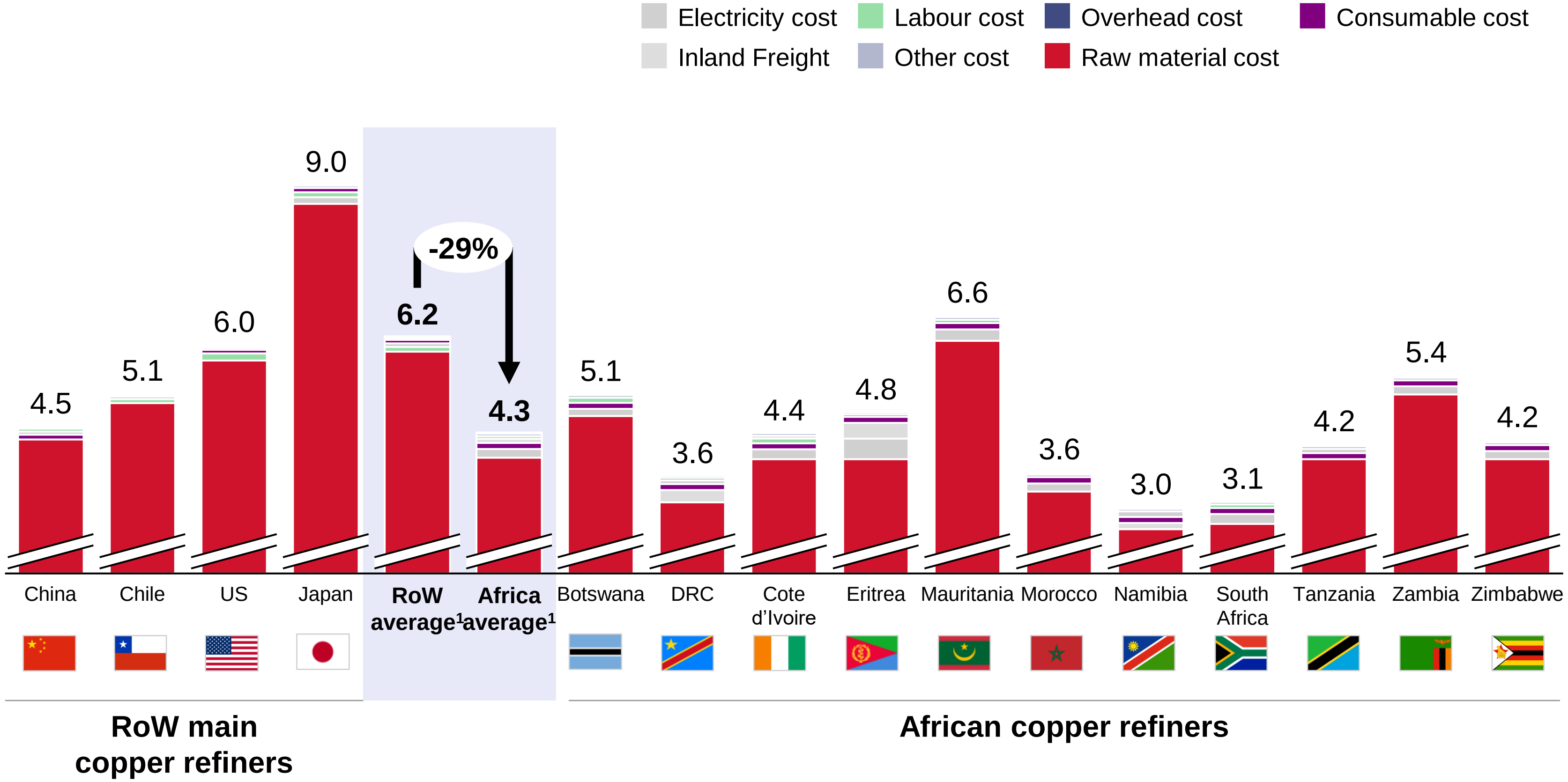
Source: McKinsey MineSpans, Expert interviews

Due to their integration with mines, African countries are on average 25-30% more competitive than refineries in the RoW

AS OF JULY 2024 **OCEAN FREIGHT NOT INCLUDED IN THE ANALYSIS (ON AVERAGE 0.5%-2% OF TOTAL COST)**

Weighted average cost breakdown for copper refining facilities, 2030

USD thousands/tonne of refined metal



1. Average of the countries considered for the analysis: Africa (Botswama, DRC, Ivory Coast, Eritrea, Mauritania, Morocco, Namibia, South Africa, Tanzania, Zambia, Zimbabwe; RoW (China, Chile, US, Japan)

Source: McKinsey MineSpans, Expert interviews

Key insights

Raw materials costs, comprising **more than 90%** of total refining expenses, allow **African copper refiners** to gain a competitive edge through **raw material integration**, making them **25-30%** more competitive than he **average RoW refineries**

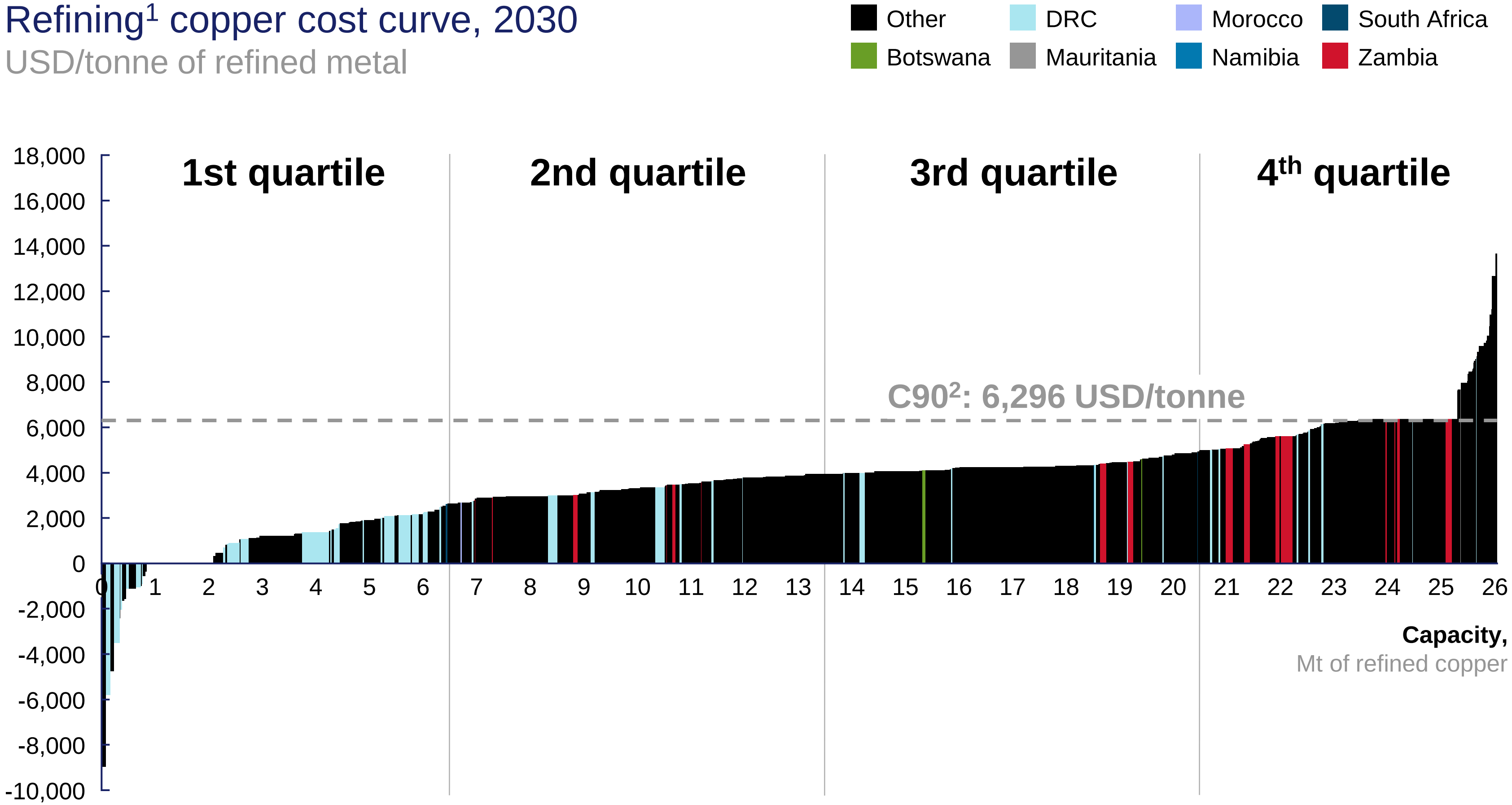
Copper deposits in Africa, particularly in the **DRC**, **Namibia**, and **South Africa**, contain **higher-grade copper** compared to those in **China**, **Chile** and the **US,** providing African countries with a significant **cost competitive advantage** in refining copper

Most of the African players are positioned in the 1st and 2nd quartiles of the cost curve

AS OF JULY 2024 **OCEAN FREIGHT NOT INCLUDED IN THE ANALYSIS (ON AVERAGE 0.5%-2% OF TOTAL COST)**

Refining[1] copper cost curve, 2030

USD/tonne of refined metal



Key insights

Cost competitiveness is predominantly determined by the **quality of the raw material**, as refining costs constitute only **2-3% of the total cost**

The **geological setting**, incl. the types of mineralized rocks and the quality of the deposit, is crucial for **positioning a mine** on the **left side** of the **copper refining cost curve**

Countries with **varying deposit qualities** across different sites, such as Zambia, exhibit **different positions** on the **cost curve**

1. Cost curve of mining which includes refining costs
2. 90th percentile usually referred to as cost of marginal producers

Source: McKinsey MineSpans

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 identified 4 main factors essential for African countries to succeed in cell manufacturing

FOR DISCUSSION **PRELIMINARY**

▨ Deep-dive on the next pages

Success factors	Potential pathways to be successful for African countries	Successful example
Access to technological and manufacturing intellectual property	Invest in **R&D** and **strategic partnerships** to **acquire** and **develop** proprietary technologies, collabourate 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

Cell manufacturing cost competitiveness analysis – scope definition

PRELIMINARY

Categories	Focus of the analysis	Rationale
End market	**Europe** as the potential end market for **African-manufactured batteries**	• 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**
Battery technology	**Li-ion technology**	• By 2030, **LFP technology** will account for **more than half** of the global battery cell demand • Europe, lacking domestic **LFP production**, presents a significant opportunity for African manufacturers to meet the region's demand, as European stakeholders aim to reduce import reliance from **China**
Time horizon	**Cost competitiveness in 2030**	• Given the **rapid evolution of battery technology** and the **potential emergence of new technologies** (e.g., Sodium-Ion post-2030, focusing on the 2030 horizon allows for an effective evaluation of the current trajectory and competitiveness
Countries	• **Africa:** Tanzania (Sub-Saharan Africa) and Morocco (North-Saharan Africa) • **RoW:** China, Indonesia, Europe, US	**Africa** • Tanzania has one of the most robust mining capacities in Sub-Saharan Africa (e.g., gold, nickel), with the port of Dar es Salaam already exporting raw materials from other African countries (e.g., cobalt from DRC) • Morocco already has a well-developed battery-related manufacturing industry and will be the first African country to open a gigafactory **RoW** • **China:** World's largest producer of batteries • **Indonesia:** The country is investing heavily in battery-related manufacturing and aims to become a global hub for battery production • **Europe:** Europe is investing in developing its own battery-related manufacturing capabilities • **US:** US IRA is also driving the development of a domestic battery supply chain, reducing reliance on imports

Source: Battery insights, Expert interviews

The BoM is the primary cost driver in cell manufacturing, accounting for ~70% of the total cost

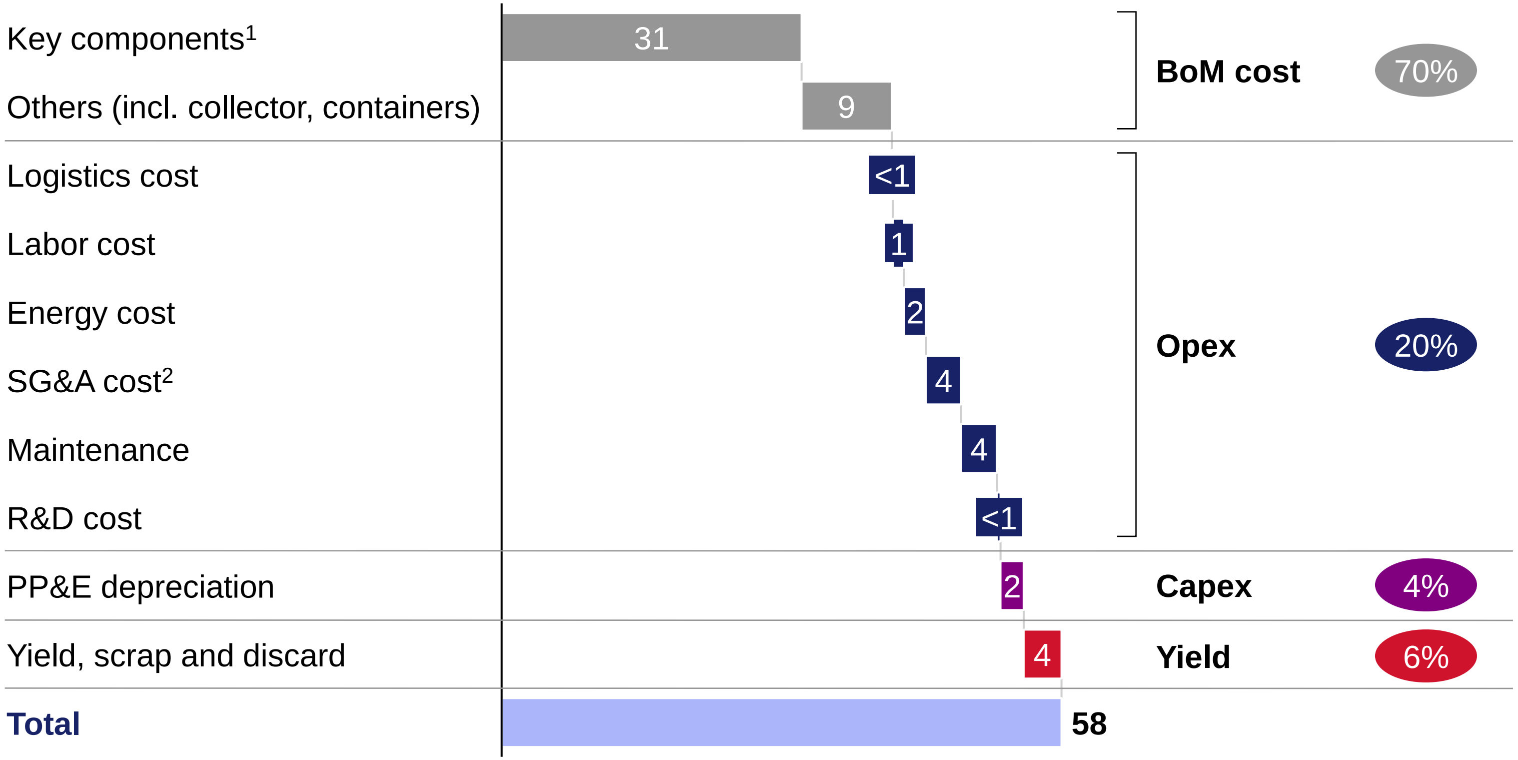
Example for a Chinese gigafactory, in 2030

Q2 2024

Cell manufacturing cost breakdown

USD/kWh

Share of total cost



Key insights

In China, BoM accounts for ~**70% of the total battery cell cost**: the percentage can be even higher in other countries, as China benefits from **value chain integration**, an extensive **domestic supply chain**, and **upstream-integrated cell manufacturers**

Operational costs make up **~20% of the total**, primarily due to **equipment maintenance** and **indirect costs** (e.g, SG&A)

Capex costs would be higher in other countries, as China benefits from **local equipment suppliers**, and **lower regulatory requirements**

*China's battery cell industry achieves **economic efficiency** through its **integrated supply chain** and **upstream manufacturing advantages***

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1. Incl. cathode, anode, electrolyte, separators
2. Selling, general, and administrative expenses

Note: Li (carbonate) price: 18 USD/kg (2030)

Source: Battery insights, Expert interviews

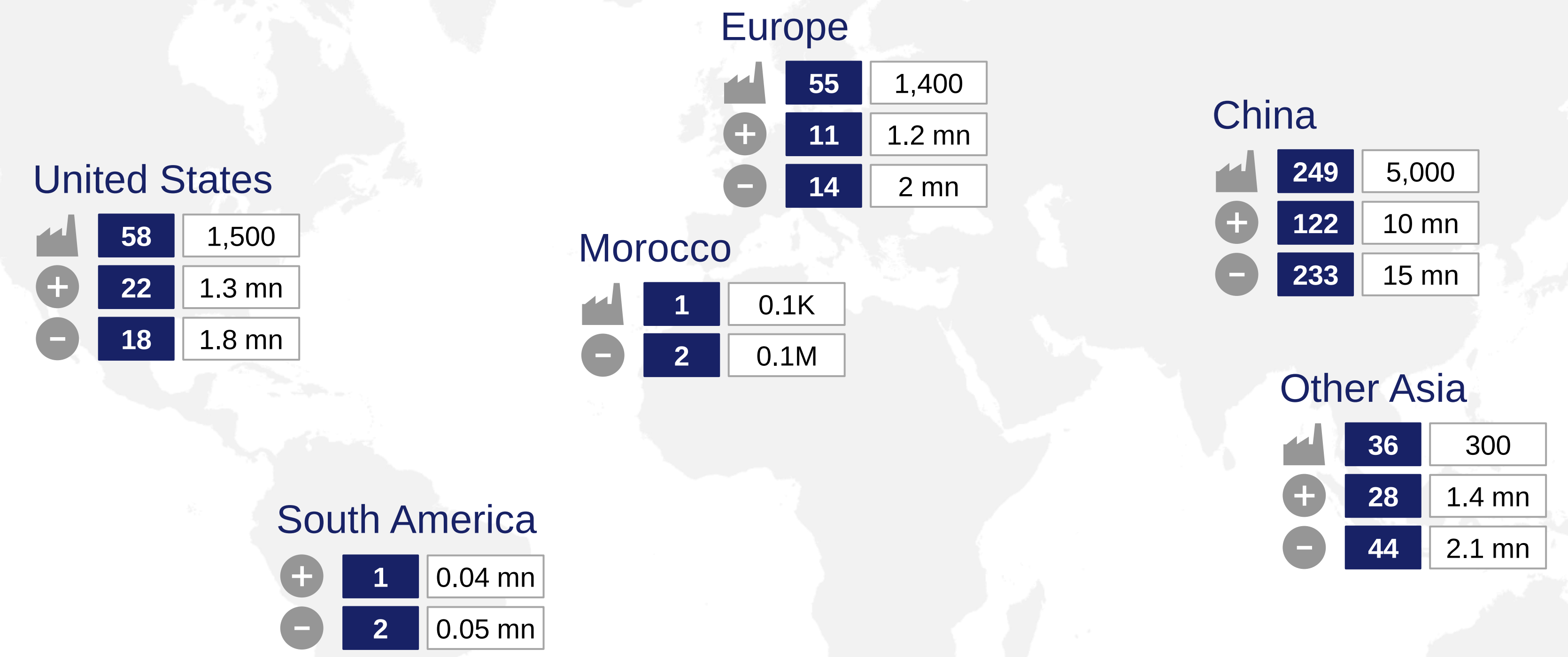
Most African countries would need to rely on imports in 2030 due to lack of local active materials

World map of expected battery active materials[1] and cell producers in 2030

Q2 2024

- 🏭 Gigafactory
- ⊕ Anode plant
- ⊖ Cathode plant

- ■ Number of plants
- □ Yearly capacity, TWh for gigafactory
Yearly capacity, mn tonnes for anode/ cathode plants



Europe

🏭	55	1,400
⊕	11	1.2 mn
⊖	14	2 mn

China

🏭	249	5,000
⊕	122	10 mn
⊖	233	15 mn

United States

🏭	58	1,500
⊕	22	1.3 mn
⊖	18	1.8 mn

Morocco

🏭	1	0.1K
⊖	2	0.1M

Other Asia

🏭	36	300
⊕	28	1.4 mn
⊖	44	2.1 mn

South America

⊕	1	0.04 mn
⊖	2	0.05 mn

Key insights

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

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)

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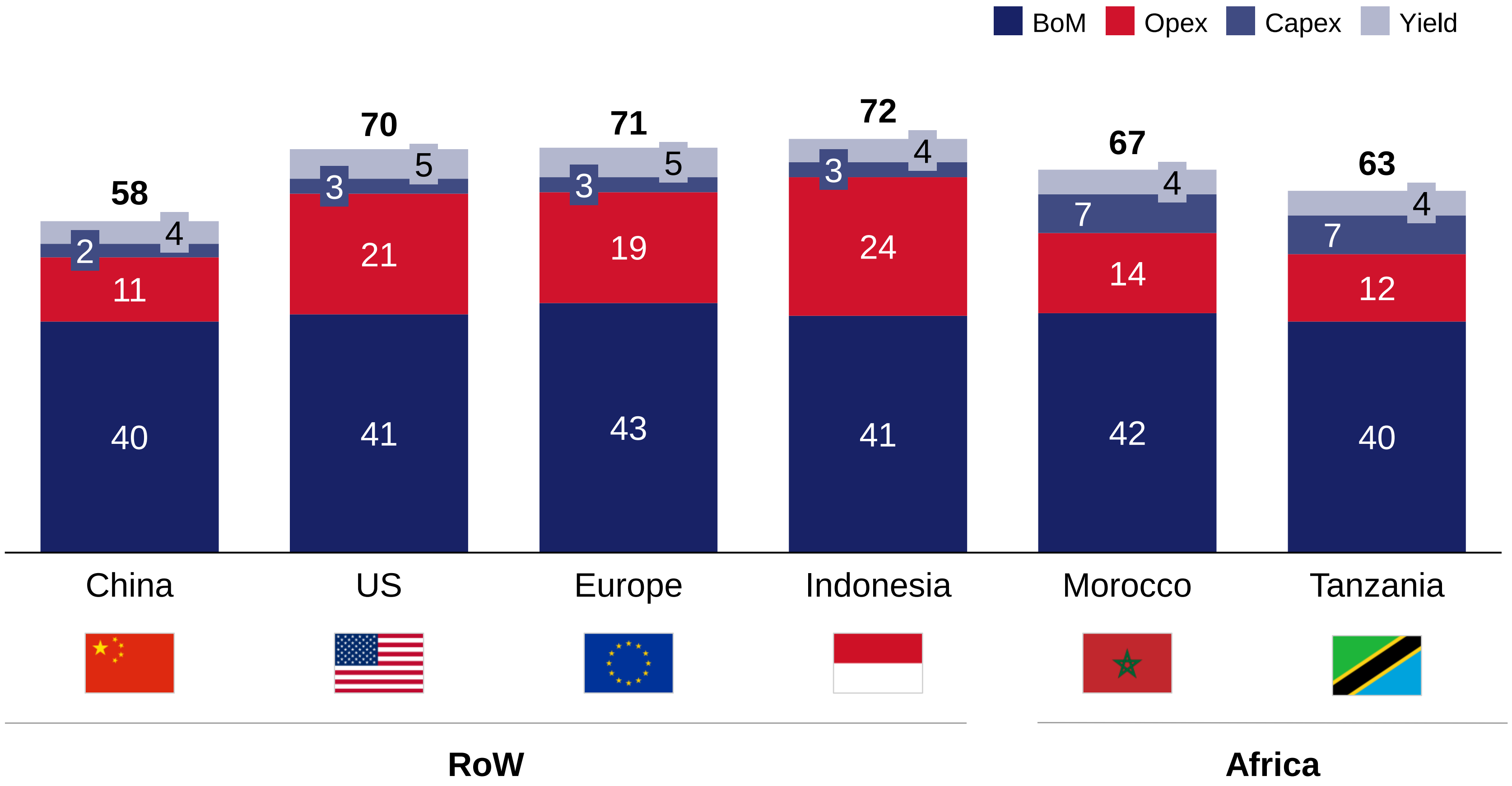
1. Cathode and Anode only: excluded from the analysis electrolyte and separators as not tracked in the model

Source: Battery insights, Expert interviews

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**

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:

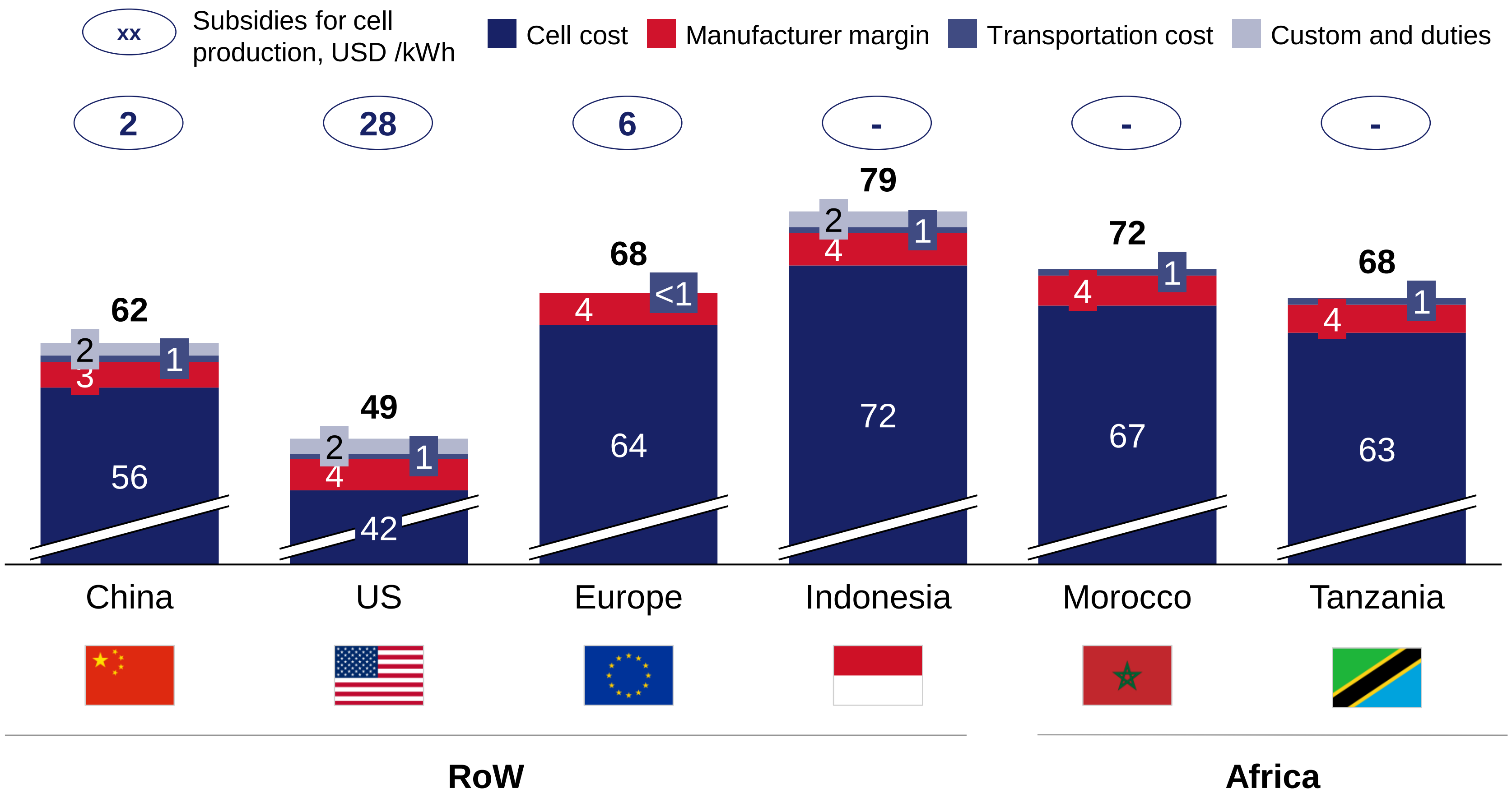
- Access lower **operational costs** (e.g., cost of labour, cost of electricity)
- **Procure BoM** at competitive rates thanks to **SEZ,** allowing to import materials from China with a **0% import duty**

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**

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

● 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**	◑

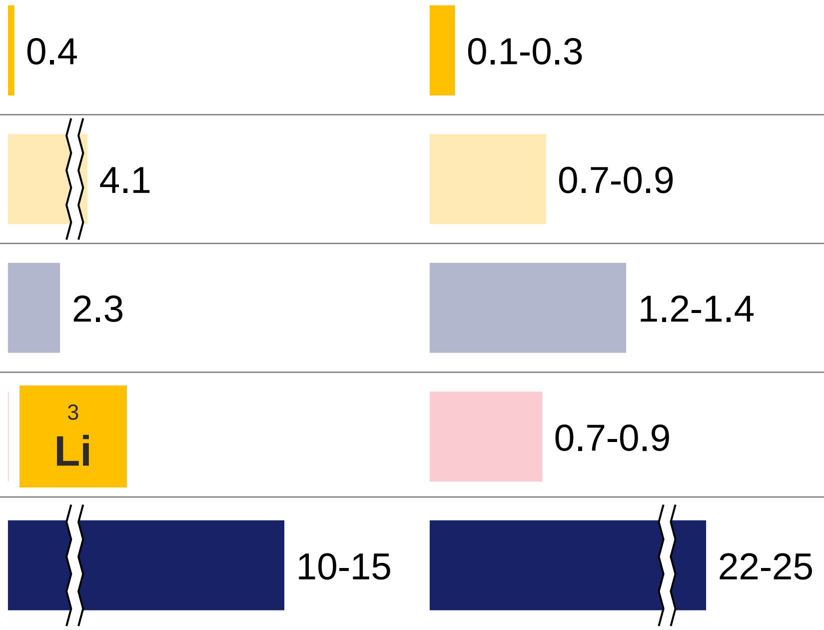
1. Assessment based on Expert interviews

Source: Expert interviews

The downstream integration in the battery value chain would generate economic and social impacts for African countries

AS OF JULY 2024　　HIGH LEVEL ESTIMATION

Potential impact per plant, 2030



Value chain steps		Annual revenues/ value-add[1], USD Bn	Direct jobs created, FTE thousands[2]	Assumptions
Refining, refining plant[3]	3 Li **Lithium**	0.4	0.1-0.3	Lithium refinery plant with **~20,000 tonnes** LCE capacity
	29 Cu **Copper**	4.1	0.7-0.9	Copper refinery plant with **~500,000 tonnes** capacity
	28 Ni **Nickel**	2.3	1.2-1.4	Nickel refinery plant of **~100,000 tonnes** capacity
	25 Mn **Manganese**	3 Li	0.7-0.9	Manganese refinery plant of **~50,000 tonnes** capacity
Cell manufacturing, gigafactory[4]		10-15	22-25	Gigafactory with **100 gWh annual production** Annual value-add-based announcement of Tesla's **100 GWh** gigafactory in Nevada Direct jobs created based the **Gotion High-Tech's announcement** for the **100 GWh** gigafactory in Morocco

1. Used annual revenues for refining and value added per KWh for cell manufacturing; 2. Direct jobs created over the life cycle of the plant for the plant-specific capacity; 3. Example of a Chinese refinery;
4. Expected value-add based on the announcement of Tesla's gigafactory in Nevada and direct jobs based on Gotion High-Tech's planned gigafactory in Morocco;

Source: McKinsey MineSpans, Battery insights, Expert interviews, Tesla, Gotion High-Tech, Electreck

Benchmarks

4

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 com-ponents	Cell pro-duction	Packaging	Application[1]			Recycling	Key insights
							2/3W	4W	ESS		
● **Morocco**	■	■	■	▨	▨	▨		▨			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)
South Africa	■	■	■	▨	▨	▨		▨	■		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
DRC **Zambia**		■	▨	⬚	⬚						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
Kenya					⬚		■			■	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
● **Nigeria**		■	▨			■	■		■	■	**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)
● **Zimbabwe**		■	▨								With **Africa's largest lithium reserves,** Zimbabwe is seeking to move up the value chain with investments from Chinese companies (e.g., Huayou)
Mauritius				⬚							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)
Tanzania	■	■	⬚	⬚					■		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**
Ghana		▨							⬚		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		■	▨								Namibia's **efforts to ban export of raw lithium** concentrates showcase its desire to **encourage local refining**

Key insights

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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

Morocco: 17 private sector players have already stated their plan to invest in battery manufacturing

🔵 Investment 🔴 Partnership

AS OF JULY 2024

Favourable country characteristics

Investment climate	**Stable constitutional monarchy** (King Mohamed VI on the throne since 1999), **attractive investment environment** (USD ~3 bn already invested by major automotive and aerospace players)
Access to raw materials	Availability of **critical materials for LFP and NMC** (incl. phosphate, copper, manganese, cobalt, nickel)
Access to markets	**Free trade agreements with the US, Turkey, the UK and the EU** (e.g., enabling Morocco to export active materials to the US under IRA)
Energy	**Stable and abundant supplies of renewable energy,** incl. solar (throughout the country) and wind (esp. in the North and South)
Labour	**Qualified labour and supply of engineers** (e.g., Renault has an R&D centre in Morocco), while remaining **relatively cheaper than in France**
Other advantages	**Experience in automobile production** (2 major European OEMs produce locally alongside >220 Moroccan auto part suppliers), with **4 types of EV cars already being produced** (although the batteries are currently imported)

Investment summary

2023

- 🔵 **Gotion High-Tech** (Chinese battery manufacturer) **USD 6.4 bn** deal for the construction of a 100 GWh battery factory – *still at MOU stage*
- 🔴 **Al Mada** and **CNGR** (Chinese producer of active materials) partner to open a manufacturing of LFP and NMC components and a battery recycling plant
- 🔴 **SRG Canada** and **China's Carbon One Energy Group** agree to develop a graphite-based anode plant for EV batteries
- 🔵 **BTR and Shinzoom** (Chinese battery manufacturers) set to invest 300 and **460 mn USD** respectively**,** to build cathode and anode manufacturing plants
- 🔵 **Tinci materials to use a USD 280 mn** investment to manufacture LFP components
- 🔴 China's **Haisum and** Morocco's **Managem** Group have signed a partnership to open a 5850t/a battery grade plant
- 🔴 **China's Yahua** and **South Korea's LG** to produce EV battery materials in Morocco (*details yet to be disclosed*)
- 🔴 **LG Chem and Huayou** to build battery manufacturing plant in Morocco

2024

- 🔵 **Hailang** to set up a battery (anode) manufacturing plant with an initial investment of USD **460 mn**

Source: Press search, expert insights

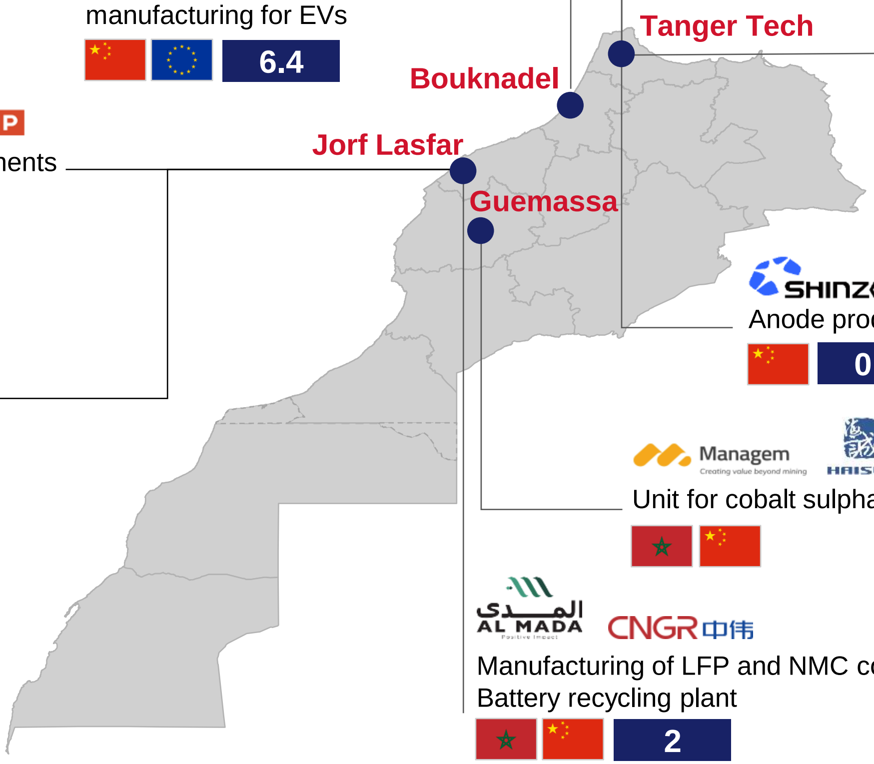
Morocco: Several investment announcements have already been published in Morocco

Roundup of current projects in Morocco, May 2024

xx Announced investment amount, USD bn

Projects of which the location has still not been identified

HUAYOU	Yahua
Manufacturing of LFP components	Unit for lithium hydroxide production
🇨🇳	🇨🇳



SRG Battery Minerals
Graphite transformation
🇨🇦 🇪🇬

BTR 贝特瑞
Cathode and anode manufacturing
🇨🇳 **0.3**

Gotion
Gigafactory: battery manufacturing for EVs
🇨🇳 🇪🇺 **6.4**

HAILIANG
Anode manufacturing
🇨🇳 **0.5**

OCP INNOVX UM6P
Pilot project of LFP components from NGB materials (R&D)
🇲🇦

SHINZOOM
Anode production
🇨🇳 **0.5**

TINCI 天赐
Manufacturing of LFP components
🇨🇳 **0.3**

Managem Creating value beyond mining **HAISUM**
Unit for cobalt sulphate production
🇲🇦 🇨🇳

المدى AL MADA Positive Impact **CNGR中伟**
Manufacturing of LFP and NMC components
Battery recycling plant
🇲🇦 🇨🇳 **2**

Key insights

~**USD 10 bn** project investments have been made along the entire battery value chain in Morocco

Majority of projects are in the **active material production** step of the value chain

Most projects are in **the North of Morocco, close to major ports** (i.e., Jorf Lasfar, Casablanca, Tanger)

Source: Press search

South Africa: Extensive R&D endeavours have been dedicated to scaling up Li-ion battery manufacturing over the years

🔵 Investment 🔴 R&D

NON EXHAUSTIVE **AS OF JULY 2024**

Favourable country characteristics

Investment climate	Ranked **4th in the World Bank's "Ease of doing business" index for Sub-Saharan Africa**, and 84th on the global index
Access to raw materials	Well-endowed **with cobalt, manganese, iron ore, nickel, and titanium** reserves
Access to markets	More **than 60% of South Africa's locally manufactured automobiles are exported**, with the majority of exports going to Europe
Energy	**Abundance of renewable energy** resources (incl., solar, wind, and coal)
Labour	Existing **technical expertise in automotive manufacturing** (South Africa's largest manufacturing industry)
Other advantages	**EV share is expected to grow to 30%** by 2030, thereby making it a viable market for battery production and sales Additionally, with the booming renewable energy storage industry there is ample opportunity to explore battery manufacturing

Investment summary

- 2011 🔴 **Establishment of a consortium** in 2011 to work on developing the li-ion value chain in South Africa (Comprising of 8 institutions, **spearheaded by the Department of Science and Innovation**)
- 2017 🔴 **Metair, University of Western Cape (UWC), and South African Institute for Advanced Materials Chemistry (SAIAMC)** to deliver locally validated Li-ion batteries over a 3-year R&D period
- 2021 🔴 Comprehensive research authored by **Trade & Industrial Policy Strategies** (a not-for-profit economic research organization in Pretoria), exploring **opportunities to develop the Li-ion value chain in South Africa**
- 2022 🔵 **Polarium** in partnership with American Tower Corporation establishes a manufacturing plant with **potential of more than 300,000 batteries**
- 2024 🔵 **Afrivolt** (a South African energy company) to establish a **Li-ion cell gigafactory to produce cathode, anodes, and Li-ion batteries for stationary storage applications, and EVs in the long term**
- 🔵 **Globeleq** to invest approximately ~USD 300 mn **to implement a battery manufacturing facility in Northern Cape**, to be utilized for ESS solutions

Source: Press search, expert insights

DRC/Zambia: Afrexim bank and UN Economic Commission for Africa are set to invest in an SEZ for battery precursors

AS OF JULY 2024

Favourable country characteristics

DRC

Investment climate	**Ranked 5th in Sub Saharan Africa on the World Bank's "Ease of doing business" index**
Access to raw materials	**~70% of global cobalt** production, **nickel exploration** is underway, one of Africa's largest **copper** producers with **lithium and manganese** reserves
Access to markets	Signatory to **the AfCFTA** agreement which aims to create a single market for goods and services across Africa, and **beneficiary of the AGOA**
Energy	**Important potential for renewable** energy (i.e., solar and wind)

Zambia

Investment climate	Ranked **44th in Africa** on World Bank's "Ease of doing business" index
Access to raw materials	Availability of **cobalt, copper, manganese, graphite,** and **nickel** resources which are useful in battery manufacturing
Access to markets	Zambia benefits from **the Everything But Arms (EBA)** initiative under which all Zambian goods exported to the EU enjoy a **duty-free and quota-free treatment,** and is also a signatory to **the AfCFTA agreement and a beneficiary of the AGOA**
Energy	Establishment of **government policies** that support **renewable energy** (Solar and wind)

Project summary

Partnership signed in April 2022 between **DRC** and **Zambia** to produce **NMC battery precursors**[1,2], using locally available raw materials (e.g., cobalt, nickel, manganese)

DRC and Zambia expect to **export their NMC battery precursors** and **manufacture in a cross-border SEZ**

MOUs have been **signed** with the **US** and the **EU** to receive technical assistance to facilitate the development of an integrated EV battery value chain; **little information has been disclosed about the advancement of the project**

Afreximbank and the **UN Economic Commission for Africa (UNECA)** will lead the establishment of an **operating company** in **consortium** with **public and private investors**

Several key topics remained unclear, incl.

- Current advancement of the project
- Location of the manufacturing plant
- Role of other countries (incl. the US, the EU, China)

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1. Material that is at the final step before becoming a cathode or an anode
2. Initial plan was to produce ~100,000 tonnes of NMC (622) precursors

Source: Press search, resource governance, UNECA website, International Trade Administration, World Bank

Kenya: Numerous mobility start-ups are setting up in Kenya, supporting a new e-mobility policy under development

● Investment ● R&D

AS OF JULY 2024

Favourable country characteristics

Kenya

Investment climate	**Ranked 3rd in Sub Saharan Africa and 56th in the world** on the World Bank's "Ease of doing business" index
Access to markets	Signatory to **the AfCFTA** agreement which aims to create a single market for goods and services across Africa and **beneficiary of AGOA**
Energy	**Important potential for renewable** energy with an estimated solar potential at ~15,000 MW
Other advantages	**Establishment of the draft e-mobility vehicle policy** to support adoption of EVs, incl. local battery manufacturing

Investment summary

2024

- ● **Roam, a Kenya-based EV company** raised USD **24 mn** to expand local manufacturing capabilities in Kenya
- ● **ARC Ride and Watu Credit** announced a strategic partnership to manufacture EVs locally, and establish battery swap stations in Nairobi

Source: Press search, press reports, World Bank

Nigeria: Chinese battery manufacturers are seeking Nigeria as a potential refining site, for its accessible lithium reserves

● Investment ● R&D

AS OF JULY 2024

Favourable country characteristics

Nigeria

Investment climate	**Ranked 17th** in Sub Saharan Africa on the World Bank's "Ease of doing business" index, and 132nd in the world
Access to raw materials	**~20 metric tonnes of Lithium** is mined annually, from specific states in Nigeria
Access to markets	Signatory to **the AfCFTA** agreement which aims to create a single market for goods and services across Africa and **beneficiary of AGOA**
Energy	**Important potential for renewable** energy (i.e., solar and wind)
Other advantages	**Quality of lithium mined in Nigeria is high grade,** standing at 13% lithium oxide content against a worldwide standard of 0.4%

Investment summary

2023	●	**China's Ming Xin Mineral Separation (MXMS)** began the construction of the country's first lithium-processing plant with a plan to manufacture batteries for EVs in Kaduna
2024	●	**Canmax technologies, a Chinese firm,** responsible for over 30 percent of global battery material production, announced an investment of USD **200mn** for a lithium processing plant in Nasarawa state in 2024
2021	●	**In 2024, Avatar New Energy Materials Company Limited,** another Chinese firm limited inaugurated a USD **500 mn** lithium processing facility

Source: Press search, press reports, World Bank

Zimbabwe: With Africa’s largest lithium reserves, Chinese investors have invested >3bn in refining raw materials

● Investment ● R&D

AS OF JULY 2024

Favourable country characteristics

Zimbabwe

Investment climate	**Ranked 21st in Sub Saharan Africa and 140th in the world** on the World Bank's "Ease of doing business index
Access to raw materials	**Zimbabwe has Africa’s largest lithium reserves** and is the world’s 6th-largest lithium producer and supplier
Access to markets	Signatory to **the AfCFTA** agreement which aims to create a single market for goods and services across Africa. Also, signatory to 31 other bilateral agreements
Energy	**Important potential for renewable** energy with a national policy aimed at **achieving 26.5% total electricity supply from renewable energy**
Other advantages	**Tax incentives** offered by the government to attract foreign investments

Investment summary

2019 ●	**China’s Zhejiang Huayou Cobalt** purchased the Arcasia Lithium project which was initially operated by Prospect Resources, for USD 422 mn
2022 ●	**Chinese investors**’ deal with the Zimbabwean government to build a metals industrial park worth **USD 2.8 bn**
2023 ●	**China’s Zhejiang Huayou** completed construction of the lithium processing plant

Source: Press search, press reports, World Bank

Mauritius: Without any raw materials, investment climate and market access are beginning to attract investors

● Investment ● R&D

AS OF JULY 2024

Favourable country characteristics

Mauritius

Investment climate	**Ranked 1st in Sub Saharan Africa and 13th in the world** on the World Bank's "Ease of doing business" index thereby attracting investments in Africa with favourable investment climate
Access to markets	Signatory to **the AfCFTA** agreement which aims to create a single market for goods and services across Africa Also eligible for **duty-free and quota-free access to exports to the EU** **Duty-free access to the Chinese market** through an an existing free trade agreement and **beneficiary of the AGOA**
Energy	**Important potential for renewable** energy, with government target for electrification with 60% renewable energy by 2030
Labour	Labour productivity[1] of USD 26

Investment summary

2023 ● **Next Source materials, Madagascar,** signed a long-term lease with Mauritius to set up a **battery anode facility** in Mauritius

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1. A measure of GDP per hour worked

Source: Press search, press reports, World Bank, International Trade Administration

Tanzania: Ongoing investments in R&D to explore battery manufacturing opportunities with graphite

● Investment ● R&D

AS OF JULY 2024

Favourable country characteristics

Tanzania

Investment climate	**Ranked 22nd in Sub Saharan Africa and 141th in the world** on the World Bank's "Ease of doing business" index
Access to raw materials	**Rich in graphite,** which is emerging as an anode material for battery manufacturing
Access to markets	Signatory to **the AfCFTA** agreement which aims to create a single market for goods and services across Africa and **beneficiary of the AGOA**
Energy	**Potential for renewable** energy (i.e., solar and wind)

Investment summary

2023 ● **EcoGraf** is undertaking a mechanical shaping study to evaluate spherical graphite (SPG) production in Tanzania, to develop a **battery anode material processing** facility in 2023

Source: Press search, press reports, World Bank

Ghana: Public private partnership is set to position Ghana as an active player in the value chain

● Investment ● R&D

AS OF JULY 2024

Favourable country characteristics

Ghana

Investment climate	**Ranked 13th in Sub Saharan Africa** on the World bank ease of doing business index
Access to raw materials	Presence of lithium and manganese reserves (which are fundamental in battery cell manufacturing) in commercial quantity
Access to markets	Signatory to **the AfCFTA** agreement which aims to create a single market for goods and services across Africa and **beneficiary of the AGOA**
Energy	**Potential for renewable** energy (i.e., solar and wind)

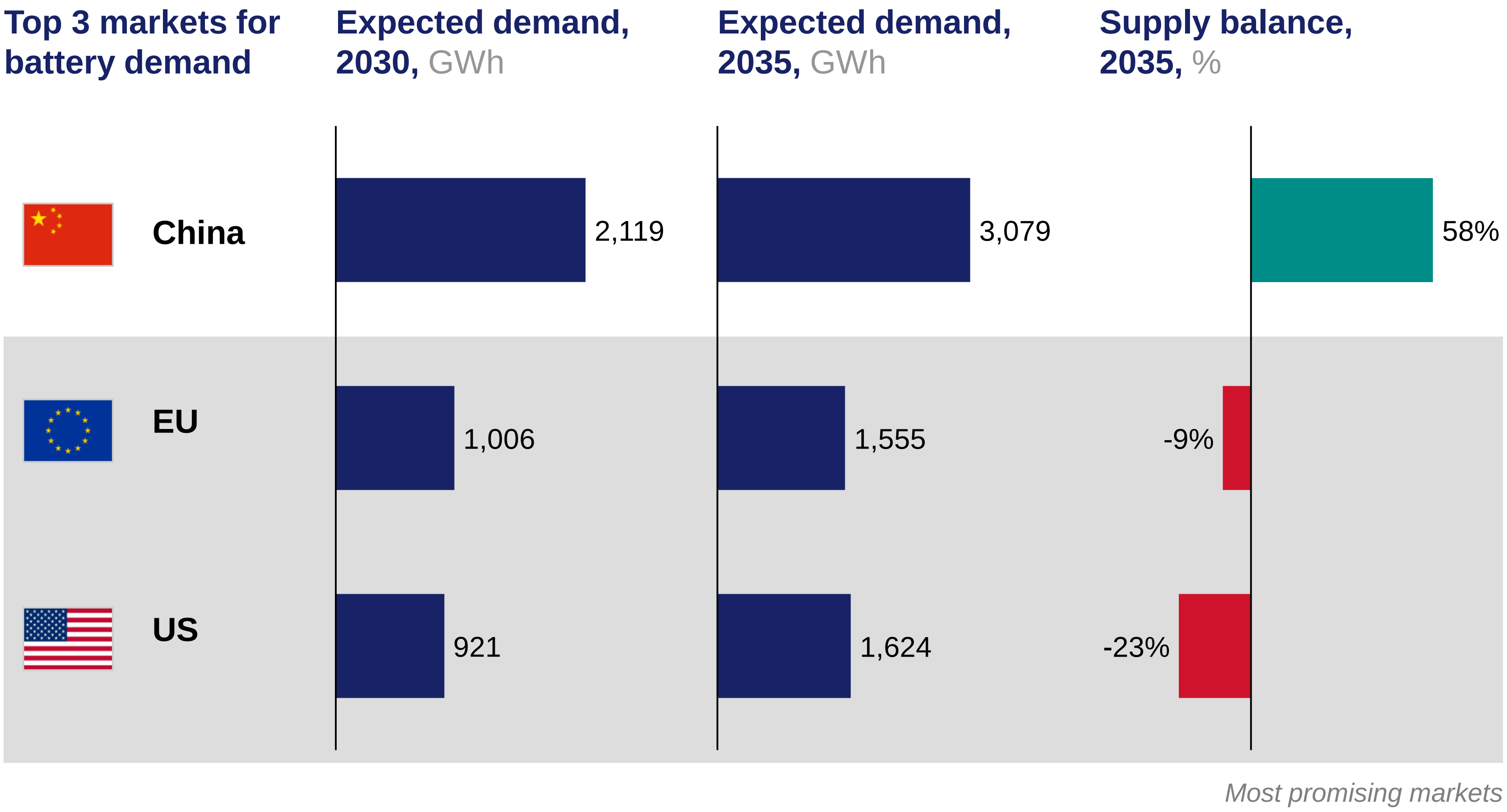
Investment summary

2023 ● Ghana **Minerals Income Investment Fund (MIIF)** announced that it closed the acquisition of a **3% stake in Atlantic Lithium**, listed in **Australia and London stock exchange,** and is on track to develop a Lithium mine in Ghana

Source: Press search, press reports, World Bank

The US and EU are the most promising export markets for battery materials, with an expected undersupply

AS OF JULY 2024



Next steps

Based on expected undersupply, the **EU and the US seem to be the most promising markets** for exports

In order to **identify opportunities for exports** of African batteries and components, we analyse **trade agreements** to understand **which countries have the most potential**

Source: McKinsey Battery insights

Through the CRM Act, the EU will ensure access to a secure and sustainable supply of critical raw materials to meet its 2030 climate and digital objectives

Summary of the CRM Act 2023

Value chain step	Act
Mining and Refining	The EU should **increase the use of its own geological resources for strategic raw materials**[1] and build up capacity to allow it to extract the raw materials needed to produce at least 10% of the union's consumption of strategic raw materials.
	The EU should also **be able to produce at least 40% of its annual consumption of strategic raw materials**
	By **2030,** the union is **not dependent** on a **single third country** for **more than 65%** of its **supply of any strategic raw material, unprocessed** and at any stage of processing, giving **special consideration** to countries with which the union has established a strategic **partnership**, a **free trade** agreement or other **forms of cooperation covering raw materials** as they provide greater assurances regarding supply risks
Recycling	The EU's **recycling capacity should be able to produce at least 25% of the union's annual consumption of strategic raw materials,** and the EU should be able to recycle significantly increasing amounts of each strategic raw material from waste

Key insights

With the introduction of the CRM Act, the **EU is committed to leverage strategic partnerships and trade agreements to distribute the supply of strategic raw materials,** i.e., eliminate dependence on a single country for supply of these resources

Strategic raw materials include lithium, graphite, manganese, nickel, and cobalt which are mined and refined in Africa and which are integral to battery manufacturing

The priority **countries reviewed in this piece have existing strategic partnerships with the EU** which puts them into consideration as a source for supply of these raw materials to the EU

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1. Strategic raw materials are: bismuth, boron, cobalt, gallium, germanium, lithium, HREE, magnesium, manganese, natural graphite, copper, PGM, silicon metal, titanium metal, nickel

Source: CRM Act 2023

The ease of exporting battery components to the EU will depend on trade agreements

List of regional trade agreements

NON EXHAUSTIVE

🟥 Carbon electrodes, battery carbons
⬜ No mention of battery-specific products
■ All products
🟩 Batteries and components
🟦 Spend, waste, and scrap of batteries (incl. cells)

Region/Country	Trade agreements	Description/implications	Products covered
Least Developed Countries (LDC)[1]	Everything But Arms (EBA)	Duty and quota free access for all products except for arms and ammunition	■
North Africa[2]	Euro-Mediterranean Agreement (EMA)	Duty-free export of all industrial products	■ 🟥 🟦
East and South Africa[3]	EU-Eastern & Southern Africa interim partnership agreement (ESA)	Zero custom fees on imports from Zimbabwe into the EU	■ 🟥 🟦
West Africa[4]	EU-West Africa Agreement (WAA) *Not yet ratified*	Duty- free exports on batteries & components upon ratification of agreement	🟩
East Africa[5]	EU-EAC Economic Partnership Agreement (EAC)	Duty-free access for all products from participatory countries except for arms and ammunition	⬜
SADC[6]	EU-SADC Economic Partnership Agreement (SADC)	Duty-free access for products from participatory countries except for arms and ammunition. Duties free access to lithium batteries and scrap batteries from South Africa	■ 🟩
Ivory Coast	EU-CIV Economic Partnership Agreement (CIV)	Duty-free access to all products from participatory countries except for arms and ammunition	⬜
Ghana	EU-Ghana Economic Partnership Agreement	Duty-free access for all products from participatory countries except for arms and ammunition	⬜

Key insights

There are different trade agreements between the priority countries and the EU which cover both **regional and country-specific trade relations.**

These trade agreements include **import-duty and quota-free access to batteries, battery components, and battery waste materials**

The West African trade agreement which Nigeria is a beneficiary of, **is yet to be ratified**, therefore, not yet operational. **Once ratified, batteries from Nigeria will be eligible for custom-free exports to the EU**

1. DRC, Ethiopia, Mozambique, Namibia, Rwanda, Senegal, Togo, Uganda, Zambia
2. Morocco, Tunisia, Egypt, Algeria
3. Zimbabwe
4. Nigeria
5. Kenya, Tanzania
6. South Africa, Zimbabwe, Namibia

Source: European Union

All of our priority countries have at least 1 trade agreement with the EU

Overview of trade agreements with the EU

NON EXHAUSTIVE

■ Eligible □ Not eligible

Priority countries	**Regional agreements**						**Country-specific agreement**
	EAC	**EMA**	**WAA**	**ESA**	**SADC**	**EBA**	
Morocco	□	■	□	□	□	□	■
Zambia	□	□	□	□	□	■	□
Togo	□	□	□	□	□	■	□
Ethiopia	□	□	□	□	□	■	□
DRC, Dem. Rep.	□	□	□	□	□	■	□
Tanzania	■	□	□	□	□	□	□
Senegal	□	□	□	□	□	■	□
Mozambique	□	□	□	□	□	■	□
South Africa	□	□	□	□	■	□	□
Ghana	□	□	□	□	□	□	■
Namibia	□	□	□	□	■	■	□
Ivory Coast	□	□	□	□	□	□	■
Kenya	■	□	□	□	□	□	□
Nigeria	□	□	▨	□	□	□	□
Rwanda	□	□	□	□	□	■	□
Uganda	□	□	□	□	□	■	□
Egypt, Arab Rep.	□	■	□	□	□	□	■
Algeria	□	■	□	□	□	□	■
Tunisia	□	■	□	□	□	□	■
Zimbabwe	□	□	□	■	■	□	□

Source: European Union

Key insights

Various trade agreements exist between the priority countries and the EU, providing import and tax benefits for selected battery products.

These include regional agreements listed below;

- Eastern Africa Economic Partnership Agreement **(EAC)**
- EU Mediterranean Agreement with North African countries **(EMA)**
- EU West Africa Agreement with Nigeria and other West African countries **(WAA)**
- EU Eastern and Southern Africa interim partnership agreement **(ESA)**
- EU Southern Africa Development Community Economic Partnership Agreement **(SADC)**
- Everything But Arms agreement **(EBA)** for least developed countries (LDCs)

Along with other **country specific agreements for Ivory Coast and Ghana,** and a few countries that have bilateral agreements (i.e., both regional and country-specific agreements), e.g., Tunisia, Morocco, Algeria, and Egypt

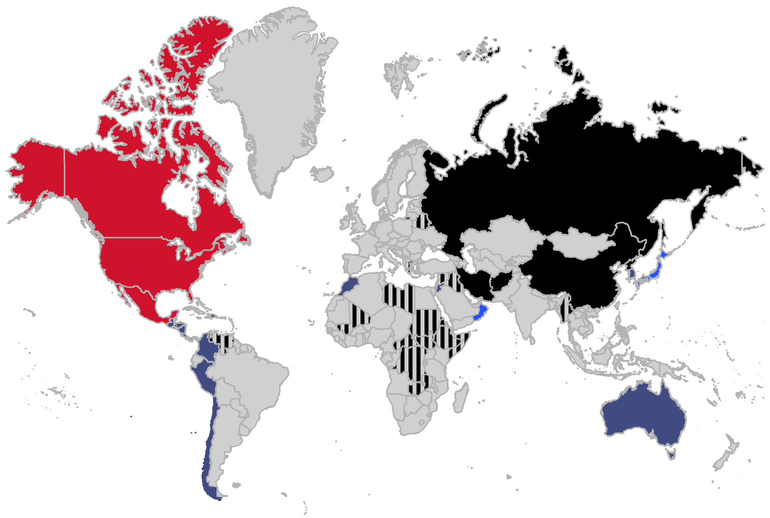
To qualify for tax credits, US automakers will need to source batteries and battery materials from countries with free trade agreements

Clean vehicle credit (30D)

MAY 2023

Map of free trade agreements

- ■ Covered nation[1]
- ▥ Countries with OFAC sanctions[2]
- 🟥 USMCA
- ■ Countries with active US free trade agreements[3]

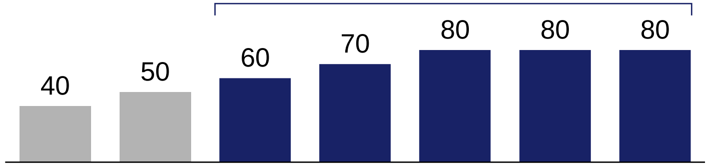


1. As defined in section 2533c(d) of title 10
2. Includes a mix of OFAC-sanctioned countries and countries with significant numbers of sanctioned industries and companies
3. Australia, Bahrain, Canada, Chile, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Israel, Japan, Jordan, Mexico, Morocco, Nicaragua, Oman, Panama, Peru, South Korea and Singapore
4. Recycled materials only qualify if recycled in North America
5. EU agreement to qualify towards critical minerals agreement being negotiated

Battery sourcing requirements

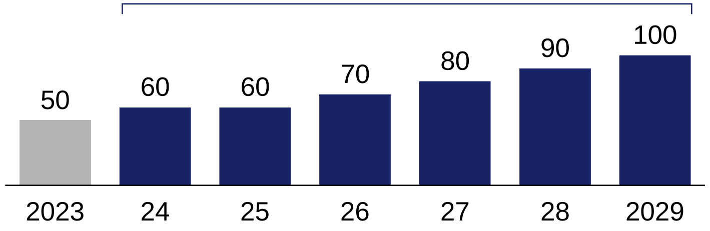
Share of critical minerals extracted/ processed in the US or a country with a free trade agreement[4,5], %

After 2024, no battery minerals may come be extracted, processed, or recycled by entities of concern



Share of battery components in North America, %

After 2023, no battery components may be manufactured by entities of concern



Battery sourcing requirements

Each of the two battery requirements is worth USD 3,750 in tax credits if other price and localisation requirements are fulfilled; complying with both achieves the full USD 7,500 credit

To qualify for EV tax credits, an increasing share of battery materials must be extracted and processed in **countries with free trade agreements incl. Morocco**

By 2029, all EV batteries must be produced in North America, beyond material source requirements

After 2024 and 2025, **battery components** and **critical minerals may not be manufactured in "foreign entities of concern"** respectively, which excludes minerals from China, Russia, and OFAC-sanctioned countries/companies, or the entire 30D credit is forfeited

Some countries have OFAC sanctions that affect state-owned businesses, individual companies, or sectors

Source: US Inflation Reduction Act (2022), 10 USC § 4872(d)(2), Infrastructure Investment and Jobs Act (2021)

Battery sourcing requirements differ based on existing trade agreements between the US and the production country

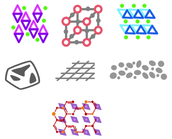
Clean vehicle credit (30D)

MAY 2023

Each requirement is complementary but independent of one another

Critical minerals requirement

USD 3,750 credit



Raw materials › Constituent materials

Critical minerals have requirements that an increasing share of value for minerals must be extracted and processed in the US or a free trade partner, or recycled in North America

If **>50% of the value-add for either extraction or processing** occurs in the US or a free trade partner, or if **>50% of the recycling** occurs in North America, the mineral counts towards requirements

Constituent materials include powders for cathode active materials, powders for anode active materials, foils, metals for solid electrodes, binders, electrolyte salts, and electrolyte additives

Battery component requirement

USD 3,750 credit

Battery components › Battery cells › Battery packs

An increasing share of manufacturing must occur in North America to qualify for IRA credits

The **value-add for each individual component is calculated and counted towards the requirements**, regardless of the composition of subcomponents

Components include cathode electrode, anode electrode, solid metal electrode, separator, liquid electrolyte, solid state electrolyte, battery cell, and battery module.

USD 3,750 + USD 3,750

Battery sourcing requirements

Automakers are responsible for sourcing the materials for battery manufacturing to qualify for incentives under IRA

To leverage IRA benefits**, they import critical minerals and battery components from countries that have free trade agreements (FTAs),** which includes Morocco.
These countries are presumed to fulfil up to 80% of automakers' demand

For the remaining demand, they can only import critical minerals, not battery components from non-FTA countries (certain African countries), excluding any trade with foreign entities of concern (FEOC)

Source: McKinsey Center for Future Mobility, McKinsey Battery insights, Inflation Reduction Act, Treasury Department, Department of Energy

Apart from free trade agreements, other trade agreements exist between African countries and the US

■ Duty-free ▨ Duties apply

NON EXHAUSTIVE

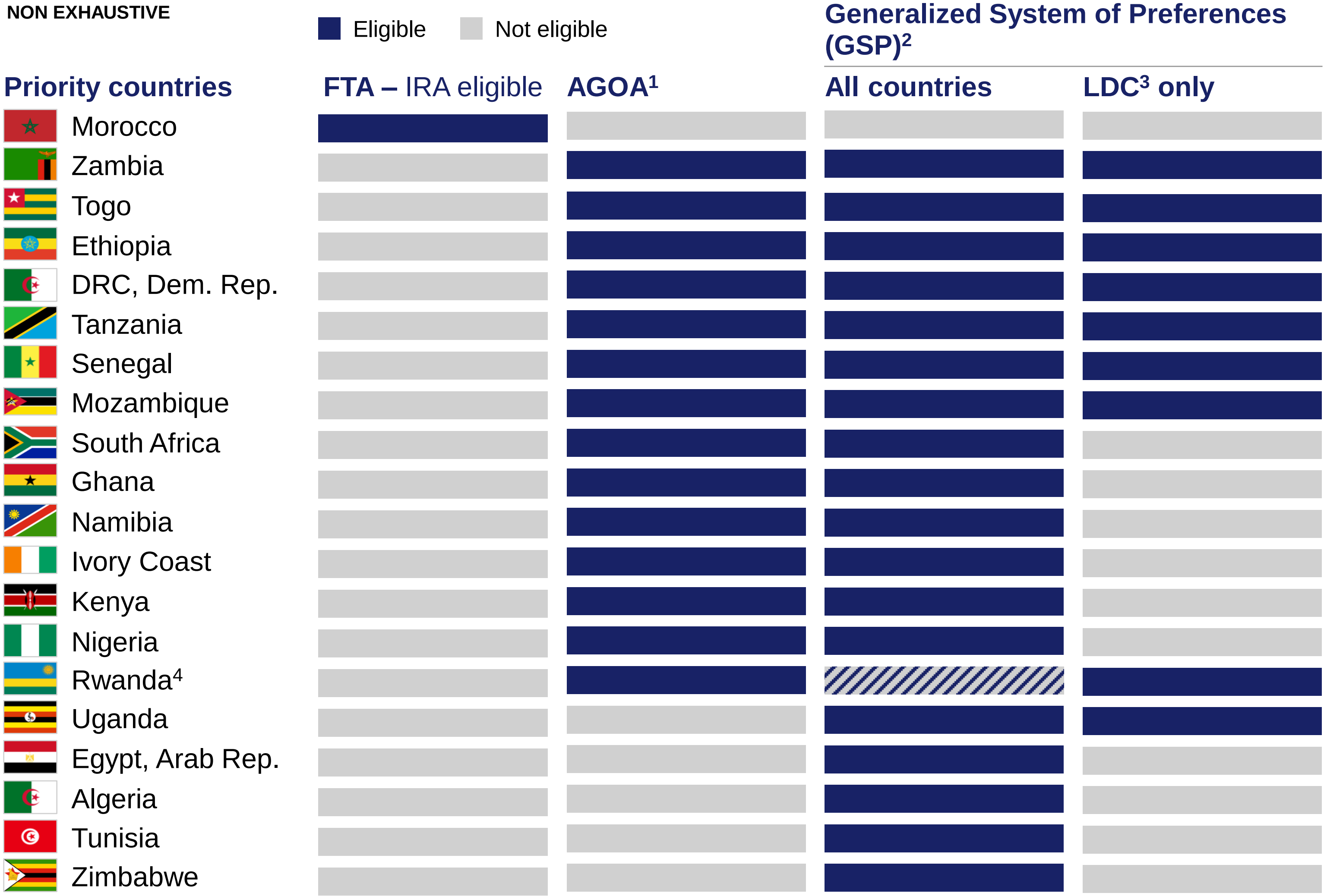
			Globalized system of preference	
	Free trade agreements – IRA eligible	AGOA	All countries	LDC only
Overall implication	Possibility to export to US tariff free and receive IRA subsidies	Possibility of exporting batteries and certain battery manufacturing raw materials and products to the US duty free	Provision of preferential access to US markets for certain battery products- not duty free	
Trade conditions specific to batteries	■ **Most goods tariff free -** TBC Restrictions on exports of batteries in 2029 – objective to have 100% made in North America	■ Li-ion batteries, Lithium primary cells and primary batteries, Lithium oxide and hydroxide ■ Parts of primary cells and primary batteries ■ Parts of storage batteries, incl. separators, excl. parts of lead-acid storage batteries, unrefined copper; copper anodes for electrolytic refining ■ Copper spent anodes; copper waste and scrap containing less than 94% by weight of copper ■ Refined copper cathodes and sections of cathodes ■ Lithium carbonate, oxide and hydroxide ■ Lithium enriched in lithium-6 and its compounds	▨ Lithium primary cells and primary batteries ▨ Parts of primary cells and primary batteries ▨ Li-ion batteries ▨ Parts of storage batteries, incl. separators, excl. parts of lead-acid storage batteries	▨ Refined copper cathodes and sections of cathodes

Source: UNCTAD, USTR, US trade

All of our priority countries have at least 1 trade agreement with the US

Overview of trade agreements with the US

NON EXHAUSTIVE



■ Eligible □ Not eligible

Priority countries	FTA – IRA eligible	AGOA[1]	Generalized System of Preferences (GSP)[2]	
			All countries	LDC[3] only
Morocco	■	□	□	□
Zambia	□	■	■	■
Togo	□	■	■	■
Ethiopia	□	■	■	■
DRC, Dem. Rep.	□	■	■	■
Tanzania	□	■	■	■
Senegal	□	■	■	■
Mozambique	□	■	■	■
South Africa	□	■	■	□
Ghana	□	■	■	□
Namibia	□	■	■	□
Ivory Coast	□	■	■	□
Kenya	□	■	■	□
Nigeria	□	■	■	□
Rwanda[4]	□	■	▨	■
Uganda	□	□	■	■
Egypt, Arab Rep.	□	□	■	□
Algeria	□	□	■	□
Tunisia	□	□	■	□
Zimbabwe	□	□	■	□

1. AGOA: Africa Growth and Opportunity Act 2. GSP: Generalized System of Preferences: Least Developed Countries (LDCs) are eligible for preferential duties under a larger selection of goods 3. LDC: Least Developed Countries 4. AGOA apparel benefits suspended by POTUS effective July 31, 2018

Source: US Trade, USTR, UNCTAD

Key insights

Free trade agreement (FTA): Morocco is the only country allowing for duty-free exports of battery *components & eligibility for IRA subsidies*

African Growth and Opportunity Act (AGOA): Most SSA nations eligible, excl. North Africa, Ethiopia, Uganda, and Zimbabwe

Globalized System of Preference (GSP)

- Overall, preferential access to the US market to all priority countries, excl. Morocco, and Rwanda for apparel
- 9 of the priority countries qualify as LDCs under GSP, entitling them to special market access and preferential treatment for specific goods

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**

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1. Local content requirement

Source: Press search, Expert interviews

Despite an initial false start, Indonesia’s comprehensive policy efforts to develop its downstream industry have led to the emergence of a robust EV ecosystem

Timeline of selected government policies to promote downstream industry and their impact on investments

NON-EXHAUSTIVE

● Tax ● Export ban ● Incentives/subsidies/grants ● Local requirements ● Infrastructure ● R&D ● PPP ✳ Investment attraction

2013 ● **Development of industrial parks**
Development of industrial parks with the necessary infrastructure to support large-scale processing facilities provided with tax incentives (e.g., Morowali Industrial Park recorded a total investment of more than USD 5 bn and provided the employment for 30,000+ workers)

2014 ● **Ban on mineral exports**
Ban on all ore exports resulting in a drop of nickel export from 60 Mt in 2013 to 0

2016 ✳ **Nickel smelter investment**
Investment of USD 15 bn by Chinese companies into nickel smelting capacities

2017 ● **Suspension of mineral export ban**
Patrial reversal of the export ban decision as a result of mounting pressure, increasing unemployment and a fall in government revenues (20% decline in Indonesia’s mining revenues and 4% decrease in the mining sector contribution to GDP to allow miners to rebuild their financial capacity to be able to invest in smelters)

2019 ● **Requirements for local content**
Gradual increase in mandatory local content requirements from 40% in 2023 to 80% in 2030, with the aim to produce EVs within the country

● **Increase in royalty rate**
Implementation of higher royalty rates for various commodities to promote downstream industries (e.g., nickel ore royalty increased from 5 to 10%)

2020 ● **Reinstatement of the mineral export ban**
Reinstatement of the export ban two years before schedule (exp. 2022) – *ban still ongoing*

● **Creation of a state-owned holding**
Creation of Mind ID, a state-owned holding company which became a major shareholder in the largest mining companies in Indonesia: Freeport Indonesia and Vale Indonesia

● **Incentives provided by the state**
Incentives such as corporate tax reduction, tax holidays (exemption for 5-25 years) and investment allowances (30% reduction of CIT) to investors within the coal and mineral downstream industry

● **Increase in domestic production requirements**
Policy enforcing a gradual increase in domestic processing of various minerals[1] to further integrate Indonesia into global supply chains

2023 ✳ **Battery plant investment**
Creation of HLI Green power, JV between the Hyundai Motor Group and LG Energy Solution to set up a USD1.1 bn 10GWh plant

2024 ✳ **EV plant investment**
Investment plans for EV production facilities by BYD (USD 1.5 bn investment, capacity of 150,000 cars) and VinFast (USD 1.2 bn investment)

Main takeaways

- **Policy Nuance**: Effective industrial policy takes into account market dynamics and overall economics, not just broad bans
- **Government Influence**: Government plays a key role in industry development through policies and incentives
- **Long-Term Perspective**: Short-term losses could lead to long-term gains, although these are difficult to predict

Key impacts

- **30x evolution in export value** from nickel raw material to processed products (From Rp 17 trillion Rp 510 trillion)
- Increase from **2 smelters in 2016 to 60 in 2023** and development further downstream
- **Attraction of FDI** in all the steps of the value chain
- Increase in the country’s **energy consumption**

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1. Including Nickel, Tin, Bauxite and Copper

Source: Government websites, press search

The Chilean government has maintained a strong presence in the mining sector through large SOEs but hasn’t been able to develop refining at the same pace

Timeline of selected government policies to promote downstream industry and their impact on investments

NON-EXHAUSTIVE

● Tax ● Export ban ● Incentives/subsidies/grants ● Local requirements ● Infrastructure ● R&D ● PPP ✳ Investment attraction

1971 **Nationalisation of copper mines**
Nationalisation of major copper mines and creation of Codelco, a state-run company responsible for a significant portion of copper production in the country

2017 ● **Incentives for lithium products**
Opening of the first call for national and foreign companies, to express their interest in manufacturing lithium products, such as battery cathodes and electrolytes. Companies that are selected would be guaranteed 25 per cent of US producer Albemarle’s lithium production at the lowest cost available in the market

2022 ● **Launch of new investment plan**
Launch of a package of measures that aim to increase investment, incl. tax incentives for private investment (e.g. suspension of part of copper royalties on a new project for 5 years), improved access to financing, better public investment, promoting foreign direct investment and making regulations more efficient

2023 ● **R&D support for lithium production**
Funding of USD 6.9 mn for up to 10 research projects to address technological, environmental, and social challenges of lithium production

Creation of a state-owned company active in lithium
Establishment of the National Lithium Company ("Empresa Nacional del Litio"), with the participation of the state throughout the entire lithium production cycle

2024 ● **Public-Private Partnership (PPP) for lithium production**
Partnership agreement between Codelco and local miner Sociedad Química y Minera (SQM) to enter a PPP)to increase the lithium production in the country’s Salar de Atacama salt flat

Main takeaways

- **Challenges in value addition**: Despite efforts to promote domestic refining, Chile still exports a significant portion of its minerals as raw materials, indicating ongoing challenges in moving up the value chain
- **State participation:** The Chilean government has maintained significant involvement in the mining sector through state-owned companies that allow for state control while still attracting private investment

Key impacts

- **Growth in copper production**, making Chile the world's largest copper producer, though **share of refined copper** relative vs. total production **decreased** as mining volumes increased
- Mining contribution represents **10% of government revenue** in recent years through royalties and taxes

Source: Government websites, press search

Zimbabwe successfully began to attract FDI following its investor-friendly policies and restrictions on raw ore exports

Timeline of selected government policies to promote downstream industry and their impact on investments

NON-EXHAUSTIVE

● Tax ● Export ban ● Incentives/subsidies/grants ● Local requirements ● Infrastructure ● R&D ● PPP ✳ Investment attraction

2020

Indigenisation act update
Removal of all minerals from the indigenization act (requiring majority ownership by indigenous Zimbabweans) to encourage FDIs

2021 ●

Ban on raw chrome exports
Ban of raw chrome exports to capacitate current smelters and maximise the local value chain with a 1-year delayed application to allow producers to adjust accordingly

2022 ●

Base minerals export control act
Ban on raw base minerals ore exports, requiring companies to set up plants in the country and process ore into concentrates before export in order to boost local jobs and revenue

●

Investment on a mine-to-energy industrial park
Signature of USD13 bn deal between Eagle Canyon International Group Holding Limited, Pacific Goal Investments and the Government for the construction of a "mine to energy industrial park" to produce Li-ion batteries

2023 ✳

Processing plants commissioning
- Zhejiang Huayou Cobalt opened a USD 300 mn lithium processing plant with a capacity of 450,000 tonnes of lithium concentrate
- Chengxin Lithium Group commissioned a lithium concentrator to produce 300,000 tonnes
- Sinomine Resource Group completed a USD 300 mn lithium plant
- African Chrome Fields (ACF) completed a USD 2 bn investment in an aluminothermic smelting plant near its Kwekwe mine

●

Chrome export ban exemptions
Exemption of some chrome mining companies constructing smelting furnaces from a raw ore export ban to enable them to raise capital

2024 ✳

Government announcement of battery grade lithium production
4 lithium mining companies have tabled plans to produce battery-grade lithium in Zimbabwe according to a government official

Main takeaways

- **Emphasis on local value addition**: Zimbabwe has consistently pushed for beneficiation and local processing of minerals, aiming to capture more value from its natural resources within the country
- **Gradual shift towards investor-friendly policies**: Recent years have seen a move away from strict indigenisation requirements for most minerals, indicating a recognition of the need for foreign investment

Key impacts

- **Attraction of FDIs,** especially from China, on refining operations

Source: Government websites, press search

Namibia seeks to develop its mineral beneficiation industry through a mix of varied policies, incl. its latest export ban

Timeline of selected government policies to promote downstream industry and their impact on investments

NON-EXHAUSTIVE

● Tax ● Export ban ● Incentives/subsidies/grants ● Local requirements ● Infrastructure ● R&D ● PPP ✳ Investment attraction

2015 ●

National Equitable Economic Empowerment Framework (NEEEF)
Policy that aims to facilitate the empowerment of disadvantaged Namibians. NEEEF focuses on many aspects incl. practical training and skills development and value addition through the lens of local content promotion – *t*his policy is not promulgated yet

2016

Namibia Investment Promotion Act (NIPA)
Policy that targets FDI and encourages the creation of value addition to natural resources and to accelerate the growth and diversification of the Namibian economy –This policy is not promulgated yet

2021

Mineral beneficiation strategy
Policy that seeks to enhance the mining sector's value-added productive capacity by creating attractive opportunities for new investors in mineral beneficiation and manufacturing industry. It has the objective to increase the level of mineral beneficiation activities along the value chains by at least 50% per year by 2025 and at least 85% by 2030

●

Harambee Prosperity Plan
Policy that focuses on 4 core sub-pillars for infrastructure development: energy (supply security), water (supply security), transport (strengthening transport and logistics networks), and ICT (coverage expansion)

2023 ●

Critical minerals export ban
Ban of the export of certain critical minerals; the critical minerals identified by the Cabinet are unprocessed crushed lithium ore, cobalt manganese, graphite and rare earth elements

✳

Lithium plant investment
Investment of USD mn 33 from Xinfeng Investments Ltd in the construction of a state-of-the-art lithium processing plant in compliance with the government's calls for value addition of raw materials in the country

Main takeaways

- **Policy-driven approach**: Namibia has proposed various policies to encourage local processing and beneficiation
- **Infrastructure focus**: Recognition that developing local value addition requires significant improvements in infrastructure, incl. power supply, transportation, and water resources
- **Skills development emphasis**: Plans to enhance local expertise in mineral processing through education and training programme

Key impacts

- Attraction of FDIs for lithium processing facilities

Source: Government websites, press search

Zambia’s copper refining sector couldn’t develop due to the lack of a stable policy that encourages local beneficiation

Timeline of selected government policies to promote downstream industry and their impact on investments

NON-EXHAUSTIVE

● Tax ● Export ban ● Incentives/subsidies/grants ● Local requirements ● Infrastructure ● R&D ● PPP ✳ Investment attraction

2011 ● **Export ban on raw metal exports**
Ban imposed on metal exports incl. copper to promote local beneficiation

● **Lift of the export ban on raw metals exports**
Lift of the imposed ban on metal exports less than a week after promulgating it following an outcry from miners

2013 ● **Lift of the export tax on unprocessed copper**
Lift of the 10% tax on unprocessed copper concentrates exports to allow mining companies release surplus stocks

● **Restauration of the export tax on unprocessed copper**
Restoration of the 10% tax on unprocessed copper exports less than a week after lifting it

2016 ● **Export ban threats**
Threats to impose a ban on the export of copper concentrates meant to pressure mining companies to process more copper locally – the ban was eventually not implemented

2018 ● **National industry policy**
Objective to increase the manufacturing sector growth to an average of 20%, and increase its contribution of GDP to 15% with a focus on process raw materials domestically (e.g., copper, cobalt)

Main takeaways

- **Uncertain policies**: Zambia's quick back-and-forth on metal export bans and taxes shows the difficulty of balancing government goals with mining industry concerns
- **Failure in developing a downstream industry**: Absence of a policy environment that incentivizes investment in domestic processing facilities

Key impacts

- Zambia still exports most of its copper in a raw form losing the value-add of refined copper

Source: Government websites, press search

Several African countries have successfully developed large manufacturing projects through public PPPs (1/2)

NON EXHAUSTIVE

	Grand Ethiopian Renaissance Dam (GERD)	Dangote Refinery
Issue addressed by the project	Addressing **Ethiopia's need for energy security** and **economic development** through **hydroelectric power generation**	Addressing **Nigeria's dependence** on **imported refined petroleum products** and boosting **domestic refining capacity**
Project summary	The GERD project involves the **construction of a large dam** (6 GW hydro project) on the Blue Nile River to **generate electricity** and **support irrigation** (partially operational as of 2022, full completion expected around October 2024)	Dangote Refinery is one of the **largest refinery projects in Africa**, aimed at **refining crude oil** into various **petroleum products domestically** The project has the ambition to **meet 100%** of **Nigeria's refined** product needs (already possible with current capacity)
Main activities	**Government contribution** • **Regulatory Support**: Facilitation of necessary environmental and regulatory approvals and negotiation with Egypt and Sudan • **Investment**: Provided USD 5 bn for the construction • **Infrastructure Development:** Logistical support **Private sector contribution** • **Expertise**: Expertise in dam construction, hydroelectric technologies and project management	**Government contribution** • **Regulatory Support**: Facilitation of permits, policies promoting domestic refining • **Financial incentives**: Land allocation, Tax breaks **Private sector contribution** • **Investment**: Dangote Industries provided USD 19 billion for the construction of the refinery • **Sustainable practices**: Usage of the latest technology to comply with stringent guidelines and regulations to protect the local environment
Impact	**Economic impact:** Enabling significant export revenues through regional energy integration **Environmental impact:** 6,000 MW of electricity generation upon completion providing sustainable energy to millions of people and enterprises **Qualitative impact:** Symbol of Ethiopia's ambition on the African continent	**Economic Impact:** Capacity to process 650,000 barrels of crude oil per day and replace imports; employ 100K Nigerian youths; generate over USD 2.1 bn in revenue **Qualitative Impact:** Symbol of domestic industrial development by becoming the world's largest single-train refinery; increased energy security; potential for downstream petrochemical industries

African countries that have successfully developed **large manufacturing projects** demonstrate a willingness to **take big bets** through substantial **resource** mobilisation and collaboration between **private** and **public** sectors, resulting in significant **economic** growth, **environmental** benefits and **social** improvements

Source: Company websites, company reports, industry reports, desk research

Several African countries have successfully developed large manufacturing projects through public/private partnerships (2/2)

NON EXHAUSTIVE

	Sasol	Renault in Morocco
Issue addressed by the project	Addressing **South Africa's energy needs** and **industrial development** through **synthetic fuel production**	Developing **Morocco's automotive manufacturing sector** to attract **global investments** and **diversify the economy**
Project summary	Sasol, founded in 1950, is a **major player** in **synthetic fuel production**, converting **coal** and **natural gas** into **liquid fuels** and chemicals It has become a **major player** in the **global chemicals** and **energy sector**, with a diversified product portfolio operating in over **30 countries**	The **Renault project** was the result of a **major industrial partnership** aiming to establish Morocco as the African **car manufacturing** hub; **Renault's plant** in **Tangiers** was established in **2012** with an initial capacity of production of **400,000 cars**
Main activities	**Government contribution** • **Investment**: funding through loans and loan guarantees during its establishment phase • **Technology transfer**: Supported R&D efforts to adapt and improve Fischer-Tropsch technology to local condition • **Financial incentives:** Tax cuts, tariff protection **Private sector contribution** • **Investment**: After its privatization, Sasol continued developing partnerships with private companies (e.g., Oryx GTL with Qatar Petroleum) • **Sustainable practices**: Prioritized five Sustainable Development Goals to ensure a environmentally, socially and economically sustainable business	**Government contribution** • **Regulatory Support**: Launch of Industrial Acceleration programs prioritizing the sector • **Infrastructure development**: Development of the Tangier-Med industrial port complex, establishment of industrial acceleration zone dedicated to the automotive sector • **Education and training**: Opening of targeted training schools (IFMIA) to develop technicians • **Financial incentives**: Land allocation, Tax breaks **Private sector contribution** • **Investment**: Renault invested USD 1.2 billion to launch its plant in Morocco with other following investments • **Technology transfer**: Renault invested to develop the local ecosystem of automotives to increase its share of local sourcing
Impact	**Economic impact:** Sasol is currently employing 30K people; project contributes to 4.7% to South Africa's GDP **Qualitative impact:** Established South Africa as a major player in the Synthetic Fuels Industry; contributed to import substitution and energy security in South Africa	**Economic impact:** Established Morocco as a car manufacturing hub; current capacity of 700,000 cars (plans to reach 1M by 2025) and 13B USD of annual exports; 14,000+ jobs created with plans of enabling the creations of 50,000 more jobs **Qualitative impact:** Positioned Morocco as a leading car manufacturer in Africa; demonstrated effective public-private collaboration for large-scale industrial projects

African countries that have successfully developed **large manufacturing projects** demonstrate a willingness to **take big bets** through substantial **resource** mobilisation and collaboration between **private** and **public** sectors, resulting in significant **economic** growth, **environmental** benefits and **social** improvements

Source: Company websites, Company reports, Industry reports, Desk research

Other countries around the world have benefited from government support to develop their manufacturing industries (1/2)

NON EXHAUSTIVE

	TSMC	PT Indonesia Battery Corporation (IBC)
Issue addressed by the project	Addressing **Taiwan's dependence** on **foreign chipmakers** and **limited domestic production capacity** in the booming **electronics industry**	Leveraging Indonesia **vast nickel resources** to **diversify its economy**, create jobs, reduce carbon emissions and position Indonesia as a **global leader** in the **EV battery supply chain**
Project summary	TSMC was founded in 1987 with the ambition to **establish a world-class contract chip manufacturer** and achieving self-sufficiency for Taiwan The Company manufactures chips based on **specifications of other companies** (e.g., like Apple or Qualcomm) and has become a global leader in this field	IBC was **established in 2021** through a joint venture between **state-owned enterprises Mining Industry Indonesia**, **PT Aneka Tambang**, **PT Pertamina**, and **PT PLN** The project involves the creation of a **complete battery supply chain**, from **nickel mining** to **battery cell production**, with international partners (e.g., LG Chem and CATL)
Main activities	**Government contribution** • **Regulatory support:** Relaxation of import/export restrictions for essential materials and equipment and environmental regulations **Financial Incentives:** Tax incentives incl. deductions for R&D expenses and capex expenditures on new equipment • **Education and training:** Government investment in science and engineering education **Private sector contribution** • **Investment:** Attraction of foreign investment and continuous investments in R&D and expansion projects • **Technology transfer:** Pushing the boundaries of miniaturization, performance, and efficiency • **Sustainability practices:** Initiatives to reduce its environmental impact	**Government contribution** • **Regulatory Support:** Streamlined regulatory processes • **Financial Incentives:** Provided USD 1 bn in tax breaks and subsidies • **Infrastructure Development:** Invested USD 500 mn in logistics infra. • **Education and Training:** Launched training programs for 10K workers **Private sector contribution** • **Investment:** USD 9.8 bn investment by IBC and partners • **Technology Transfer:** LG Chem and CATL provided advanced manufacturing technologies • **R&D:** Collaborative R&D with USD 200 mn investment • **Sustainability Practices:** Implemented eco-friendly mining and manufacturing processes
Impact	**Economic impact:** Semi-conductor industry is 13-15% of Taiwan's GDP **Qualitative and social:** Continuous developments on the field through a 6B USD in R&D investment in 2023; TSMC's leadership in the semi-conductor field grants Taiwan significant strategic importance in the global economy	**Economic impact:** Attracted 9.8B USD in foreign investment; generated 20K direct and 30K indirect jobs; contributed 1.5% to national GDP growth **Environmental impact:** Aims to reduce 100 mn tonnes of CO_2 emissions by 2030: implemented sustainable mining & manufacturing practices **Qualitative & social impact:** Advanced battery technology through R&D investment; developed a skilled workforce with 10,000 trained workers; positioned Indonesia as a leading global battery supplier

Countries that have successfully developed **large manufacturing projects** demonstrate a willingness to **take big bets** through substantial **resource** mobilisation and collaboration between **private** and **public** sectors, resulting in significant **economic** growth, **environmental** benefits and **social** improvements

Source: Company websites, Company reports, Industry reports, Desk research

Other countries around the world have benefited from government support to develop their manufacturing industries (2/2)

NON EXHAUSTIVE

POSCO (South Korean steel manufacturer)

Issue addressed by the project

Reduce the **dependence on foreign suppliers** by achieving **self-sufficiency** in iron and steel

Project summary

POSCO was **established in 1968** by the **Korean government** with the ambition to develop a local industry: it was funded by **Japan** and **beneficiated** from the **technical assistance** of **Nippon Steel**

The company **produces a wide range of steel products**, incl. hot rolled steel, cold rolled steel, plated steel and stainless steel

Main activities

Government contribution

- **Investment:** The company was founded by the Korean government and funded through government grants, loans and credits from Japan
- **Regulatory support:** Import substitution policies
- **Financial incentives:** Export incentives, tax incentives e.g., corporate income tax break

Private sector contribution

- **Investment:** 55B USD investment planned by 2030
- **Technology transfer:** Technology cross-licensing with other main players (e.g., Tata Steel)
- **Sustainability practices:** Focus on sustainable products such as green steel (plan to launch by 2030)

Impact

Economic Impact: Generates around USD 60 billion per year; Generated 30,000 direct jobs

Technological impact: Significant investments in R&D which fuels innovation in product offerings and manufacturing processes

Qualitative impact: Established South Korea as a steel powerhouse; Developed downstream industry in the country

Countries that have successfully developed **large manufacturing projects** demonstrate a willingness to **take big bets** through substantial **resource** mobilisation and collaboration between **private** and **public** sectors, resulting in significant **economic** growth, **environmental** benefits and **social** improvements

Source: Company websites, company reports, Industry reports, desk research

From Minerals to Manufacturing

Africa’s Competitiveness in Global Battery Supply Chains

Final Report – Annexure

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