Lithium-ion Battery Precursors

Exploring opportunities for Rwanda in the Lithium-ion Battery Precursor supply chain

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Data sources and research approach

We have combined insights from interviews with Subject Matter Experts, stakeholder meetings, secondary data analysis and our proprietary market research and knowledge in the preparation of this report

Primary research

Proprietary market knowledge

- Leverage of our own network and insights from previous work in the industry

Subject Matter Experts

- Interviews with selected Subject Matter Experts in the industry

Stakeholder meetings

- Information provided by key stakeholders in Rwanda

Lithium-ion Battery Precursors Market Study

Secondary research

Press research/articles

- Automotive IQ
- European Commission
- Factiva
- International Lithium Association
- UNECA

Market reports

- AfDB
- Bloomberg
- McKinsey
- UN
- Volta Foundation
- World Bank

Databases

- BMI Research / Fitch Solutions
- European Battery Alliance (EBA)
- International Energy Agency (iea)
- S&P Global Market Intelligence
- Statista

Glossary

Term	Description	Term	Description
3Ts	Tantalum, Tin and Tungsten	**ICE**	Internal Combustion Engine
AAM	Anode Active Material	**LIB**	Lithium-ion battery
AfCFTA	African Continental Free Trade Area	**LIBP**	Lithium-ion battery precursor
AfDB	African Development Bank	**LDV**	Light Duty Vehicle
APS	Announced Policies Scenario	**LFP**	Lithium Iron-Phosphate
BEV	Battery Electric Vehicle	**LMO**	Lithium Manganese Oxide
CAGR	Compound Annual Growth Rate	**MOU**	Memorandum of Understanding
CAM	Cathode Active Material	**NCA**	Nickel-Cobalt-Aluminium
COMESA	Common Market for Eastern and Southern Africa	**NMC**	Nickel-Manganese-Cobalt
EAC	East African Community	**OEM**	Original Equipment Manufacturer
ESG	Environmental, Social, and Governance	**PHEV**	Plug-in Hybrid Electric Vehicles
ESS	Energy Storage Systems	**REE**	Rare Earth Elements
EV	Electric Vehicle	**STEPS**	Stated Policies Scenario
FCEVs	Fuel Cell Electric Vehicles	**UNECA**	United Nations Economic Commission for Africa

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Executive summary

Executive summary (1/8)

Topic	Key insights	What this means for Rwanda
Introduction to LIB Precursors	• Precursors are chemical compounds used in the production of cathodes. Precursors are converted into cathode active materials (CAMs) when refined lithium is added to them. The cathodes are then used in the production of battery cells • Cathodes are one of the main components used in the production of lithium-ion batteries, and determine the capacity and performance of the battery • Precursors are a key component in LIB manufacturing, making up ~70% of cathode material costs, and ~40% of the overall cost of a LIB	• The **strong market fundamentals** support high global demand for LIBs • **The European market** is a high growth area and a key **potential geography of focus for Rwanda** as it is looking to localize production (or nearshoring) of LIBs instead of importing from China
Demand dynamics	**Market size** • Strong growth in demand for LIBs is expected, with ~34% CAGR to 2025, and ~23% CAGR to 2030, anchored by regulatory-driven global climate change market fundamentals • Demand for LIBs is mainly driven by growth in demand for EVs which in turn is driven by the ban of ICE vehicles as a result of global net zero targets. Significant growth in global stock of EVs is expected to 2030 given the global push for net zero targets and subsequent gradual phase-out of ICE vehicles • China is the largest market, accounting for more than 50% of global demand for LIBs in 2022; However, Europe will see the fastest growth in demand for LIBs, with ~39% CAGR between 2022-2025	

Executive summary (2/8)

Topic	Key insights	What this means for Rwanda
Demand dynamics	**Demand trends and drivers** • **Global net-zero targets** are driving electrification and subsequent demand for LIBs for both EVs and ESS • **Largest manufacturers of LIBs globally:** China is the largest producer and exporter of LIBs globally; Chinese companies are also proactively looking for investment opportunities and strategic partnerships in Europe and Americas in order to grow their global footprint • **Investment flows:** One of the main drivers for international investment flows is vertical integration by OEMs and LIB manufacturers looking to secure a steady supply of critical raw materials. Europe has become one of the top investment destination for Asian investors who are setting up battery gigafactories. Africa is well positioned in attracting investments to do with local upstream mining activities, but there is also an opportunity for Africa to act as a local nearshoring region to serve the European LIB supply chain. • **Expansion of battery production capacity in Europe:** European countries are actively looking to expand their battery production capacity to meet growing domestic demand for LIBs. Poland and Hungary are at the forefront of attracting investments in gigafactories and securing local capacity for LIB production, whilst Sweden, Norway and Finland are focusing on expanding their anode material production hubs for the European battery supply chain	• There is an opportunity for Rwanda to **partner with LIB manufacturers in Europe** who are looking to build local capacity and nearshoring solutions. Top target markets include **Poland and Hungary**

Executive summary (3/8)

Topic	Key insights	What this means for Rwanda
Demand dynamics	• **Evolution in battery chemistries and emerging battery technologies:** LIB Precursors are based on various chemistry components, each with different features and implications for their cost, capacity and performance. NMC and NCA are the most dominant chemistries for passenger EVs, whilst LFP is the dominant chemistry for commercial EVs and ESS. The industry is exploring new, more efficient battery technologies with a view to gradually move away from lithium-based batteries in the long term. There is also a growing focus on smaller battery packs, faster charging and the use of different anode materials • **LIB price trends:** The price of LIBs has been coming down, driven by economies of scale and technological innovation, and is expected to continue to fall with improvements in technology in the medium to long-term • **Greater focus on battery recycling:** There is a greater emphasis on battery recycling by OEMs and battery manufacturers in order to enhance the sustainability of LIBs and help address issues of raw material scarcity. The industry is moving from a linear to a circular value chain where used materials are repaired, reused, or recycled • **Regulatory developments:** The regulatory landscape is complex with multiple regulatory bodies at global, regional and national levels; EU and US regulations encourage localizing production of LIBs to their respective regional markets	• **NMC** is a dominant chemistry for European EVs and could be a potential areas of focus for precursor production in Rwanda • As the average price of LIBs is coming down, Rwanda needs to be able to produce precursor materials efficiently and at **low production costs**

Executive summary (4/8)

Topic	Key insights	What this means for Rwanda
Supply dynamics	**Global supply trends** • **Resource scarcity:** According to market forecasts, there could be a 55% gap in global demand vs supply of lithium in 2030 if no further mining projects are developed. Similarly, there could be a slight undersupply (~8% below demand) of nickel in 2030 given the current pipeline of mining projects • **Top producers of key LIB metals in Africa:** Africa is well endowed with the key resources required for the production of LIBs, which presents opportunities for potential collaboration between African countries in the battery value chain • **Developments in the price of key LIB metals:** There has been a rise in the price of lithium since 2017 as demand exceeded supply, whilst there has been downward pressure on the price of cobalt mainly driven by excess supply • **Greater focus on ESG issues:** Growing concerns around issues such as conflict minerals, child labour and unfair working conditions have prompted industry regulators to pay greater attention to ESG compliance	• There are opportunities for Rwanda to **collaborate and partner with regional countries** to source critical LIB Precursor minerals such as nickel, manganese and cobalt • A **focus on ESG issues in the sourcing and processing of critical minerals** will be key in ensuring Rwanda's competitive advantage in this market

Executive summary (5/8)

Topic	Key insights	What this means for Rwanda
Supply dynamics	**Rwanda's mining sector** • Rwanda's main mineral deposits include gold, the 3Ts and Rare Earth Elements. There are also **known occurrences of lithium-bearing minerals in Rwanda** with several opportunities currently being explored • Rwanda has a vision to become a **regional mineral value addition hub** by processing minerals mined in Rwanda and in the region before exporting them • Rwanda's mining sector is home to several **private sector investors** focused on exploration, development and value addition of critical raw materials. There are currently **three refinery plants** in Rwanda - Gasabo Gold Refinery (gold), LuNA Smelter (tin) and Power-X (tantalum) • Rwanda has a **robust legal and regulatory framework** that governs the mining sector, with strong government support and a willingness to improve the sector. Recent mining code changes have seen Rwanda implementing international regulatory frameworks which are attractive to foreign investors • 100% of Rwanda's **minerals are traceable from their mine site up to their export point**. Minerals are traceable through a digitalized **blockchain tagging system** which complies with international regulatory requirements • Rwanda has **robust ESG capabilities in the mining sector** with relevant policies developed, implemented and monitored via the Rwanda Environment Management Authority (REMA) and Rwanda Mines, Petroleum and Gas Board (RMB)	• Rwanda's mining and mineral value-addition sector, with its robust regulatory and ESG policy frameworks, is **well placed to attract further investments** • Rwanda has already made **great strides in mineral refining** particularly in gold, tin and tantalum, and is **well positioned to explore opportunities arising from the LIB value chain**

Executive summary (6/8)

Topic	Key insights	What this means for Rwanda
Competitive analysis	**Selected country case studies** • **DRC/Zambia -** In 2022 the USA signed a trilateral MOU with DRC and Zambia for the development of an integrated value chain around LIBs. The MOU is **widely supported by key institutions in Africa**, including the AfDB, as it is viewed as a **first step in the development of a pan-African value chain** for EV batteries. The agreement is still at non-binding stage with implementation not yet guaranteed, and it could take long to negotiate finer details • **South Africa -** Both the government and private sector have indicated their intention to position South Africa in the LIB supply chain. However, **despite several initiatives focused on developing the LIB value chain since 2011, there is still no commercial production of LIBs**, with only a pilot plant for R&D established. High electricity costs, **electricity and water shortages**, as well as **high levels of crime and governance issues** have derailed progress of LIB production in South Africa • **China -** The availability of **generous government subsidies** have been key in developing the battery manufacturing industry in China, with companies such as CATL taking advantage of such government support to build scale and expand globally. China's recent restrictions on the exports of graphite and production processing technologies are signals that **the country is consolidating its dominance and control of the supply chains** needed for LIBs and EVs.	• Rwanda can **draw lessons** from the DRC/Zambia, South Africa and China case studies, and leverage its **strengths in infrastructure, ESG capabilities and availability of government subsidies** to develop a local LIB precursor manufacturing facility

Executive summary (7/8)

Topic	Key insights	What this means for Rwanda
Competitive analysis	**Rwanda's competitive positioning and opportunities** • Rwanda has the potential to become an **LIB precursor processing hub in East Africa** by positioning itself in the centre of a regional value chain and taking advantage of growing demand in the UK and EU for nearshoring solutions in the LIB supply chain • Key success factors for Rwanda to penetrate the global LIB supply chain include **securing long-term offtake agreements** with relevant partners; **Accessing critical raw materials** for the processing of precursor materials; and **Developing technical and operational competence** to effectively execute the project • Rwanda already has standing MOUs with several countries in the region for the supply of key minerals for value-addition and processing, and is well-positioned to set up **additional MOUs with selected countries to secure the supply of critical LIB raw materials** such as Nickel, Manganese and Cobalt. • There are opportunities for Rwanda to enter into a **JV or partnership agreements with potential precursor offtakers in Europe** (e.g. in Poland). Such a JV / partnership would ensure secured funding as well as knowledge and skills transfer	• Whilst the development of a regional value chain in Rwanda presents opportunities and challenges, **Rwanda's potential as a regional hub is promising** • Rwanda needs to **identify and secure the right investors** for project implementation as well as potential offtakers for its LIB precursor materials • Rwanda is already recognized as a **mineral processing hub in East Africa**. It also already has **strong trade and economic cooperations** with countries in the COMESA region which it can further leverage to secure the supply of critical minerals

Executive summary (8/8)

Topic	Key insights	What this means for Rwanda
Competitive analysis	**Rwanda's competitive advantage** • **Strength of infrastructure:** Rwanda has robust infrastructure with a good road network, secure border, and reliable power & water availability. Although the country is landlocked there is good access to regional ports in Mombasa and Dar-Es-Salaam as well as several regional and international airlines flying directly into Kigali • **Enabling business environment:** Rwanda has put in place several incentive mechanisms which engender a strong enabling business environment and support investments in the country. These include business friendly regulations, multiple tax incentives, efficient investor processes and a commitment to foreign ownership • **Skills development:** The government of Rwanda is proactively working to mitigate the skilled workforce shortages through several strategies including engagement of expatriates and Rwandan diasporans, as well as partnering with selected countries on specific skills development programmes • **Rapid access to electricity & high reliability:** Investors in Rwanda benefit from rapid access to electricity and high reliability compared to other countries in the region. The time to obtain a permanent electricity connection in Rwanda is ~30 days compared to over 60 days in neighbouring countries • **Capabilities in the EV sector:** There are several initiatives underway in Rwanda's EV sector, including announced government targets and tax incentives. The sector is already attracting a growing ecosystem of EV startups as well as a focus from international automotive OEMs such as Volkswagen and Mitsubishi	• Rwanda enjoys several competitive advantages which uniquely position it to penetrate the LIB value chain. The **strength of Rwanda's infrastructure** and **strong governance** make it a **strong contender** to compete in this market • A more detailed **feasibility study** will need to be conducted to **evaluate the practicality of establishing a production facility** for LIB precursors in Rwanda. This will include an analysis of suitable locations, land and infrastructure requirements, plant and equipment specifications, production capacity planning, and technical feasibility assessments

Section I

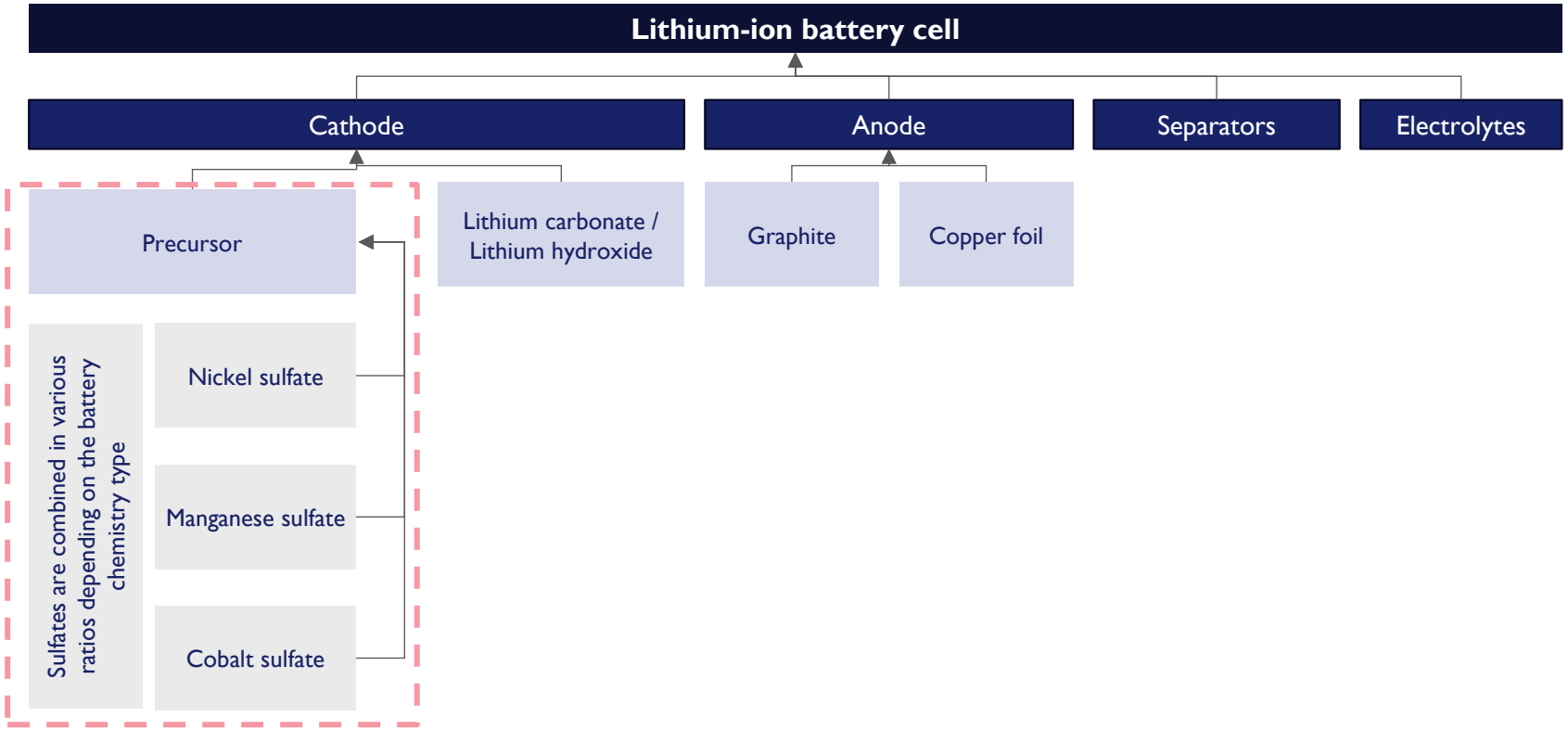
Introduction to LIB Precursors

Overview of LIB Precursors (1/2)

Scope of this report

Precursors are chemical compounds used in the production of cathodes. Cathodes are one of the main components used in the production of lithium-ion batteries, and determine the capacity and performance of the battery

Typical components of a lithium-ion battery cell



Overview

- Lithium-ion battery cells are made up of four main components: **Cathode, Anode, Separator,** and **Electrolyte.** These are all packaged into an aluminium case
- Precursors are **chemical compounds** made from **different combinations of key metals** including sulfates of nickel, manganese and cobalt
- Precursors are **key ingredients in the production of cathodes**; Precursors are converted into cathode active materials (CAMs) when refined lithium is added to them. The cathodes are then used in the production of battery cells
- The capacity and performance of a battery is determined by the **combination of metal compounds (chemistries)** used in the production of its precursors
- Precursors are a key component in LIB manufacturing, making up **~70% of cathode material costs**, and **~40% of the overall cost of an LIB**

Source: iea; Subject Matter Experts

Overview of LIB Precursors (2/2)

Precursor materials exist in powder form and can be transported via road, air and sea freight over long distances without affecting their quality

Precursor materials, e.g. nickel and cobalt sulfates (green and brown powder) + Lithium carbonate (white powder) = Cathode Active Materials (black powder)

*

The lithium content of a typical NMC/NCA cathode is ~7%, whilst LFP cathodes contain ~3% lithium

Key characteristics of precursor materials

- **Chemical compounds** consisting of metals such as nickel, cobalt, and manganese **in powder form** (hydrated metal sulfates)
- Turn into cathode active materials with the **addition of lithium** carbonate
- Not required to be co-located with battery cell manufacturers as they can be **easily transported** via road, air and sea freight over long distances without affecting their quality

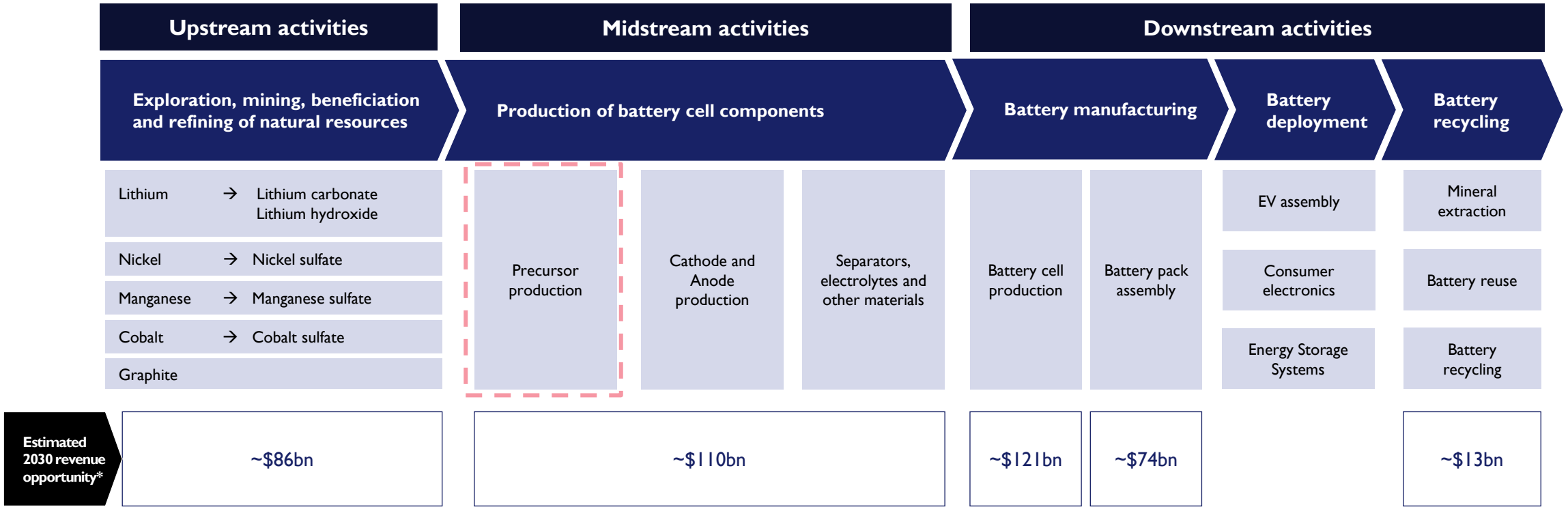
*Simplistic view for illustrative purposes only
Source: chemeurope.com, Minor Metals Trade Association (MMTA), Subject Matter Experts

Precursors in the overall lithium-ion battery supply chain

Scope of this report

Precursors are part of the midstream activities of the overall lithium-ion battery supply chain and are key in the production of battery cell components

Precursors in the overall lithium-ion battery supply chain



* Based on McKinsey's battery demand model; Total potential global revenues across the LIB value chain is estimated to be ~$400bn by 2030 from ~$85bn in 2022

Source: McKinsey Battery Insights, Subject Matter Experts

Section 2

Demand Dynamics

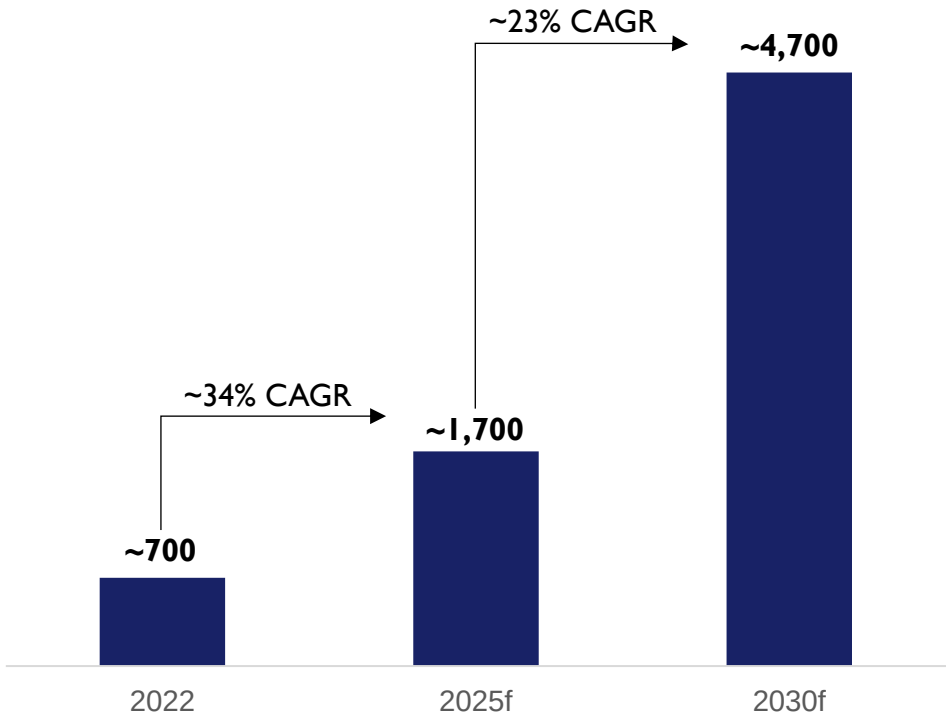
SECTION 2.1

Market size

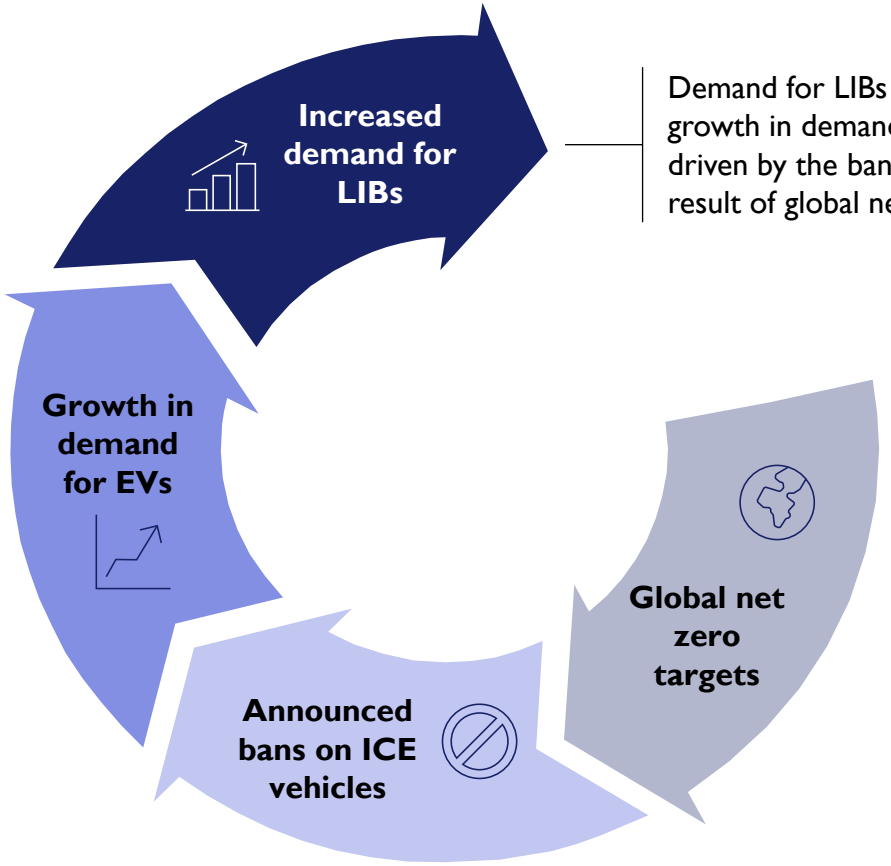
Historical and forecast demand for LIBs (1/2)

Strong growth in demand for LIBs is expected, with ~34% CAGR to 2025, and ~23% CAGR to 2030, anchored by regulatory-driven global climate change market fundamentals

Global LIB demand, GWh



Drivers of growth



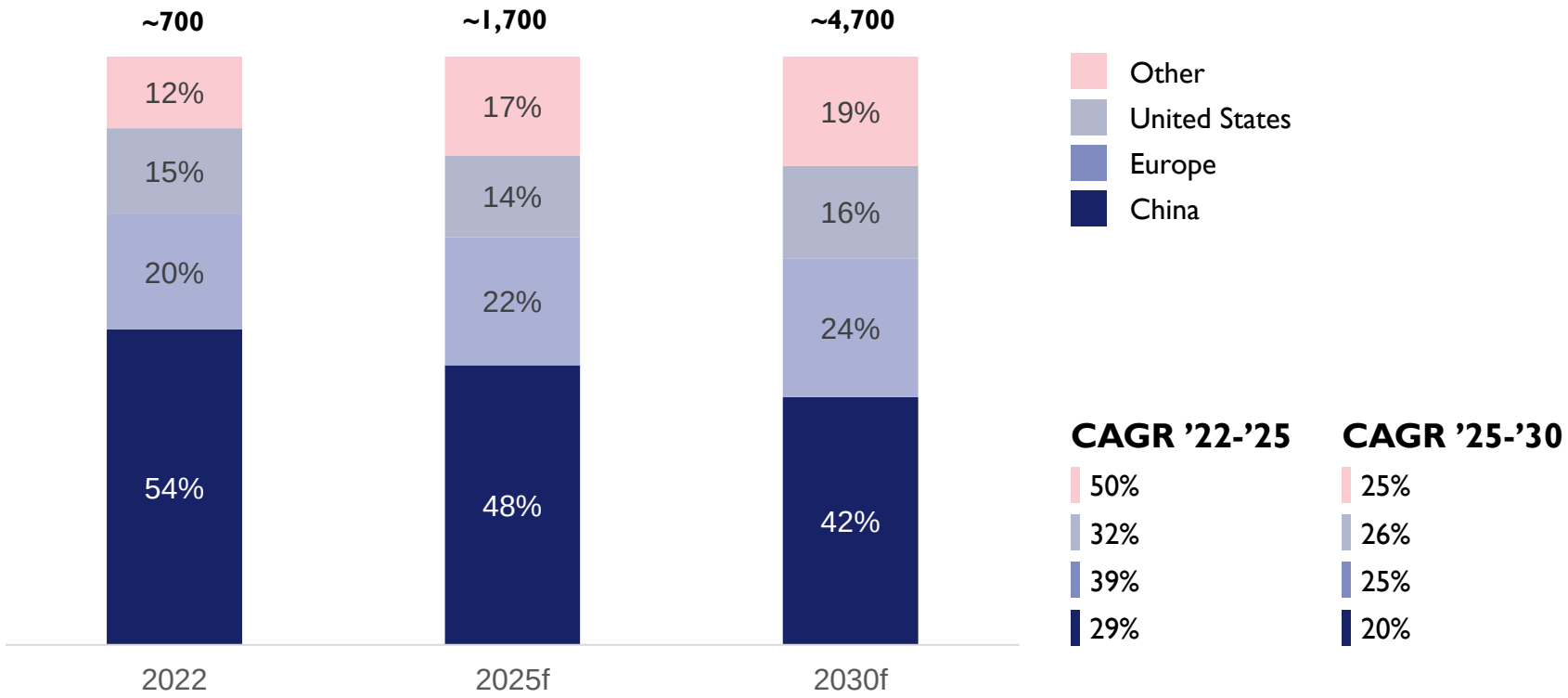
Demand for LIBs is mainly driven by growth in demand for EVs which in turn is driven by the ban of ICE vehicles as a result of global net zero targets

Source: McKinsey Battery Insights, iea, Subject Matter Experts

Historical and forecast demand for LIBs (2/2)

China is the largest market, accounting for more than 50% of global demand for LIBs in 2022; However, Europe will see the fastest growth in demand for LIBs, with ~39% CAGR between 2022-2025

Battery demand by geographical regions, GWh



Market perspectives

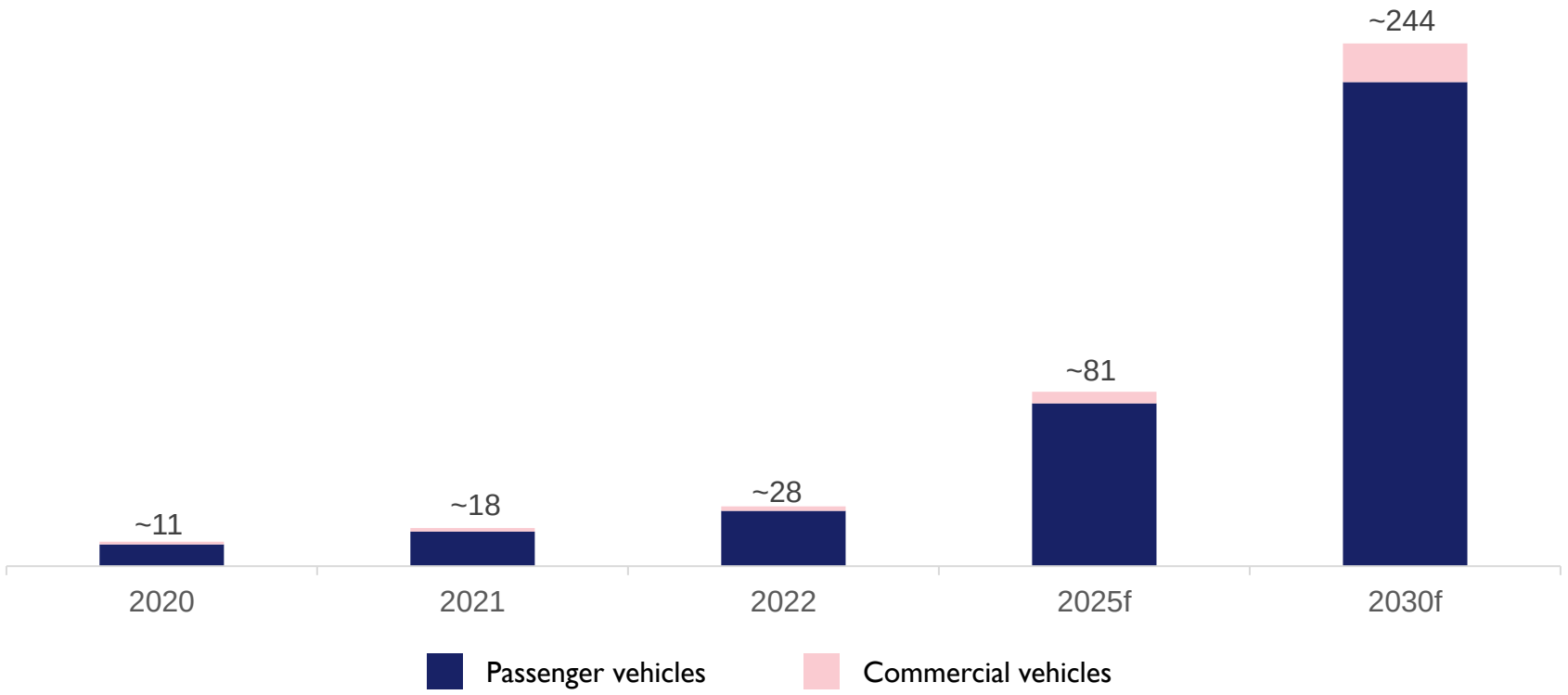
- **China is the largest market** and main driver for growth, accounting for more than 50% of total global demand in 2022. However, most battery segments are **reaching maturity in China,** and although it will remain the largest market, growth is expected to slightly slowdown relative to other regions
- **Europe and the US will see fast growth in demand for LIBs to 2030**, driven by accelerated regulatory targets towards net zero and incoming regulations on localization of LIB raw materials

Source: McKinsey Battery Insights, iea, Subject Matter Experts

Zoom on Growth in EVs

Significant growth in global stock of EVs is expected to 2030 given the global push for net zero targets and subsequent gradual phase-out of ICE vehicles

Global EV stock*, # of vehicles (millions)



* Includes both Battery Electric Vehicle (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs)

Source: iea Global EV data explorer

Market perspectives

- Significant growth is expected in the global stock of EVs in response to regulatory-driven net zero targets. Growth drivers include:
  - **Gradual ICE phase-outs** by the biggest car manufacturers
  - Availability of **EV purchase subsidies** (e.g. tax exemptions, VAT subsidies, road toll exemptions, etc.)
  - Increased investment in battery production and corresponding **investment subsidies** on offer by various governments
- Passenger EVs are the **largest segment**, but strong growth is expected in the commercial EV segment as governments push for **electrification of public transport**

SECTION 2.2

Demand trends

Overview of key market trends

Key trends

01 **Global net-zero targets**

02 **Largest producers of LIBs globally**

03 **Investment flows**

04 **Expansion of battery production capacity in Europe**

05 **Evolution in battery chemistries & emerging battery technologies**

06 **LIB price trends**

07 **Greater focus on battery recycling**

08 **Regulatory developments**

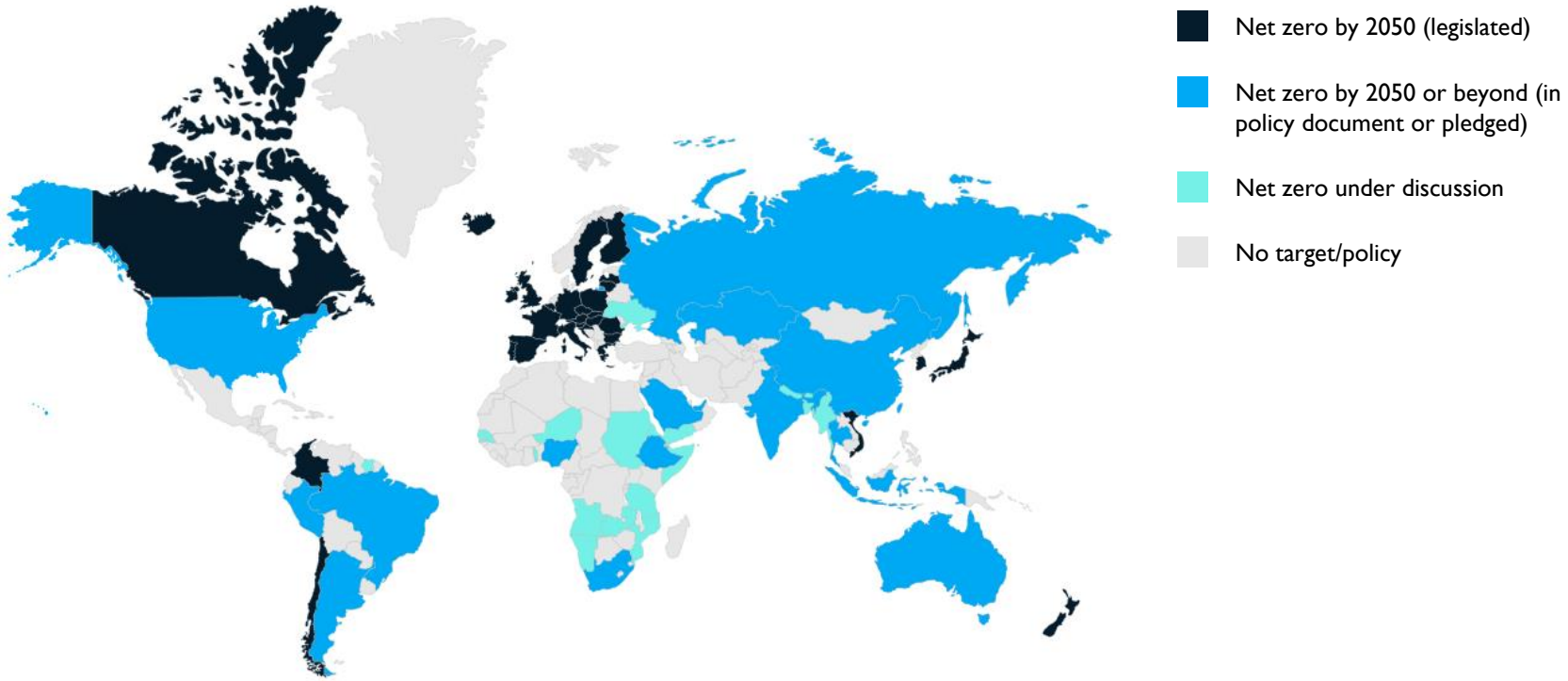
Global net-zero targets

The Paris agreement set the global path towards decarbonization by 2050

Key aspects of the Paris agreement

- The United Nations Framework Convention on Climate Change (UNFCCC) reached a landmark agreement to combat climate change at COP 21 in Paris (Dec 2015)
- The agreement was signed by 195 countries
- Key target is reducing temperature increase to below 2.0 degrees from the pre-industrial era by 2100
- The agreement requires all parties to put forward their best efforts through "nationally determined contributions" (NDCs)
- **Net-zero targets are driving electrification and subsequent demand for LIBs** for both EVs and ESS

Net zero commitments by region (as of July 2022)



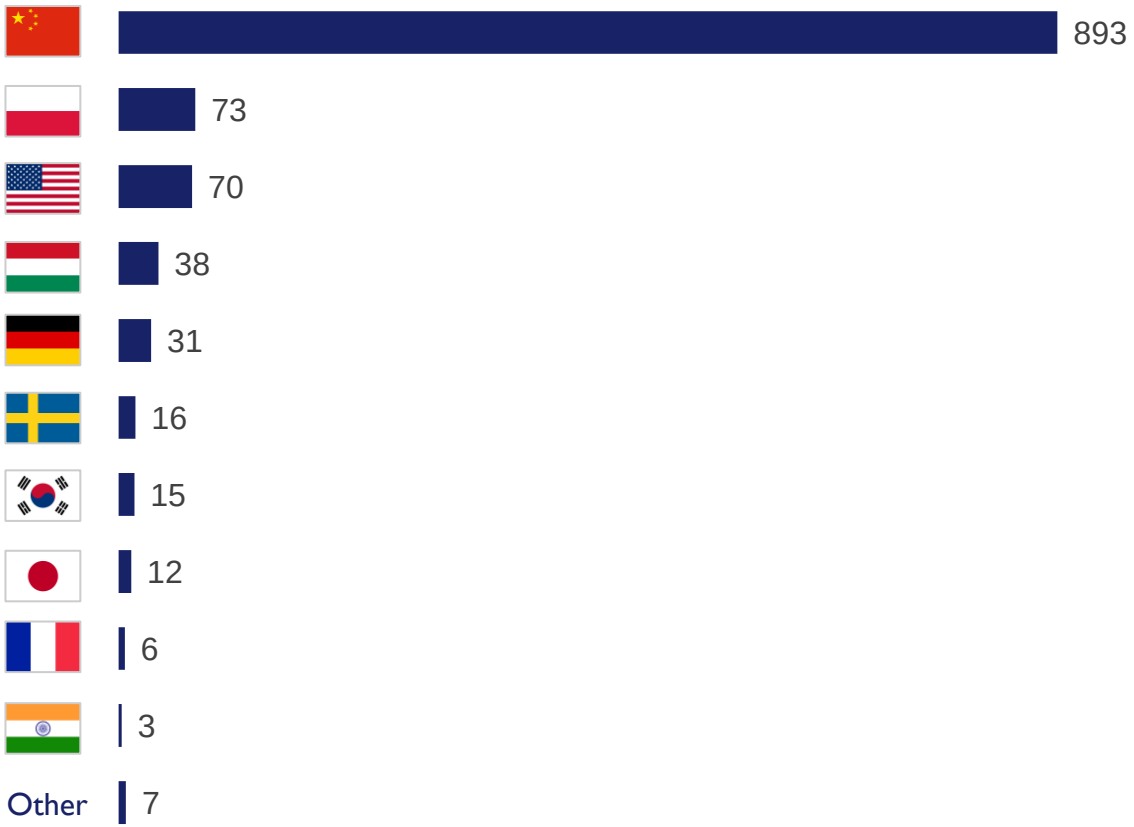
Source: McKinsey: https://www.mckinsey.com/industries/oil-and-gas/our-insights/charting-the-global-energy-landscape-to-2050-emissions

Source: McKinsey, UNFCCC

Largest producers of LIBs globally

China is the largest producer and exporter of LIBs globally, however, European countries such as Poland and Hungary are rapidly expanding operations to increase their LIB production capacities

LIB manufacturing capacity by country (2022, GWh)



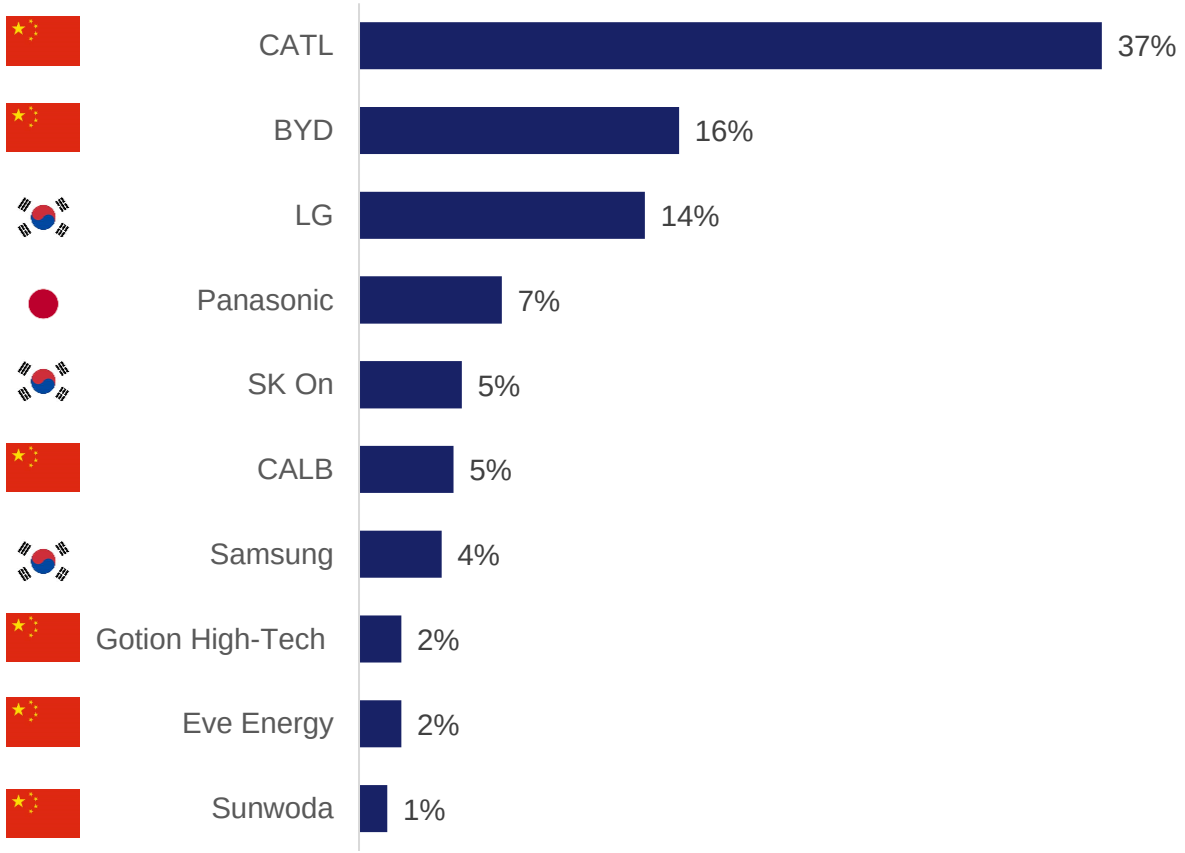
- **China** is the largest producer and exporter of LIBs globally. The largest importers are in Europe (mainly Germany) and the US
- New entrants are penetrating the market for LIB manufacturers:
  - Governments of countries involved in upstream activities are **encouraging value-add** through greater penetration along the battery supply chain
  - There is **strong government support in the US via the Inflation Reduction Act** which offers generous incentives to companies setting up greenfield LIB projects
- European manufacturers are looking to increase their LIB production capacity in the medium-to-long term
  - The **European Battery Alliance** is actively promoting battery research and manufacturing in the EU
  - The EU has set aside **grants and incentives to encourage investment** into LIB manufacturing and the establishment of gigafactories
  - European countries that are well positioned to participate in LIB manufacturing activities include **Poland, Hungary, Germany, Sweden, Norway and Finland**

Source: BloombergNEF, BMI, Statista, S&P Global Market Intelligence

Zoom on the top LIB manufacturers

Chinese companies are the largest producers of LIBs globally. These players are also proactively looking for investment opportunities and strategic partnerships in Europe and Americas in order to grow their global footprint

Estimated market shares of top LIB manufactures (2023)



- Although based in Asia, most of the large LIB manufacturers have operations in Europe and the Americas:
  - **CATL** has production bases and R&D centres in China, Germany and Hungary
  - **BYD** has production bases in China, USA, Brazil, Japan, India and Hungary
  - **LG** has production bases in South Korea, China, Taiwan, India, Poland, Germany, Australia and USA
- The large Asian players are proactively **looking for investment opportunities and strategic partnerships in Europe and Americas** to bring localization for the manufacture of LIBs in those geographies
- Key areas of focus for LIB manufacturers include
  - Securing a steady supply of critical material supplies
  - Furthering partnerships with OEMs
  - Gaining economies of scale and reducing manufacturing costs

Source: BloombergNEF, BMI, Statista, S&P Global Market Intelligence

Zoom on the top manufacturers of LIB precursor materials

The largest precursor material processors are based in China; Precursor manufacturers include science and technology companies involved in the production of not only precursor material for the LIB industry, but also other industrial chemical materials

Top manufacturers of precursors and CAM

- The top manufacturers of LIB precursor materials include **science and technology companies** involved in the production of not only precursor materials for the LIB industry, but also **other industrial chemical materials**
- The main precursor manufacturers are based in China, with some of the largest being:
  - **Ronbay Technology** – processes NMC precursor materials for CATL, BYD, Samsung and SK Innovation
  - **Easpring** – processes LCO and NMC precursor materials for LG, BYD and Panasonic
  - **XTC (Xiamen Tungsten Co.)** – processes LCO and NMC precursor materials for BYD CALB and Gotion High-Tech
  - **Dynanonic** – processes LFP precursor materials for CATL and BYD
- European-based precursor producers include:
  - **BASF in Germany** – processes NCA precursor materials for CATL's LIB factory in Germany
  - **Umicore in Belgium** – processes NCA and NMC precursor materials for LG Energy Solutions, Panasonic and Samsung
  - **Haldor Topsoe in Denmark** – processes LNMO precursor materials for Morrow Batteries, a Norwegian-based LIB manufacturer

Source: EV Markets Reports (Bax & Company), Volta Foundation Annual Battery Report

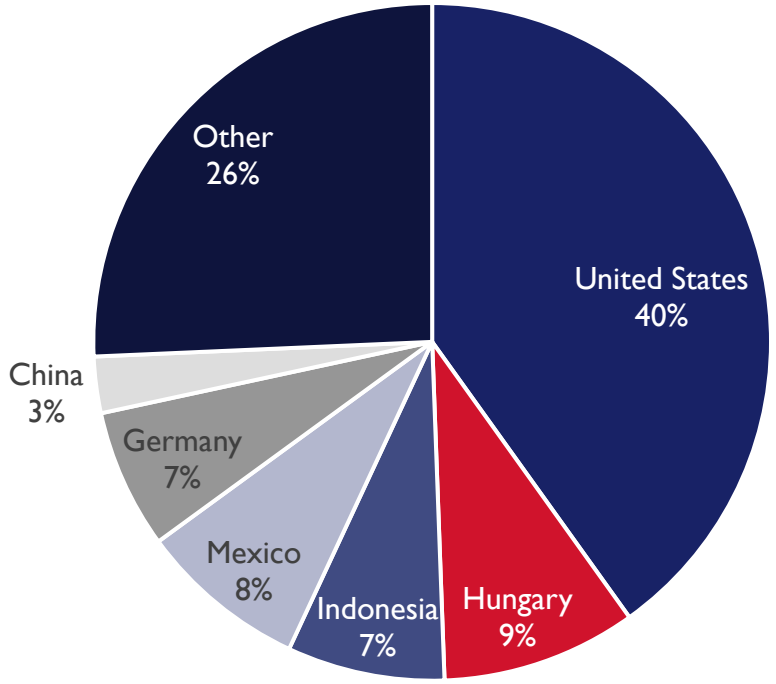
3

Investment flows (1/3)

One of the main drivers for international investment flows is vertical integration by OEMs and LIB manufacturers looking to secure a steady supply of critical raw materials

Investment into the LIB value chain by destination country

(2022, total FDI: ~$106bn)



Growing focus on vertical integration

- Top global investors into LIB value chains include OEMs as well as battery manufacturers. **Tesla** is the largest OEM investor globally whilst Chinese company **CATL** is the largest battery manufacturer investing in the LIB value chain
- One of the main drivers for international investment flows is **vertical integration** by OEMs and LIB manufacturers looking to secure a steady supply of critical raw materials. Recent examples in Europe include:
  - Swedish battery manufacturer **Northvolt** entered into a **JV with GALP** for the development of a lithium conversion plant for the **production of lithium hydroxide**
  - **Volkswagen** entered into an **offtake agreement** to secure lithium hydroxide from Australian lithium producer **Vulcan Energy**; It also entered into a **JV with Belgian firm Umicore** for the **production of precursor and CAM materials**
- Vertical integration provides **opportunities for co-location** and the **sharing of R&D, knowledge and critical resources**

Source: FDI Intelligence, European Battery Alliance

Investment flows (2/3)

Europe has become a top investment destination for Asian investors who are setting up battery gigafactories; Asian investors are shifting their focus from upstream to midstream activities along the LIB value chain

Selected recent Asian investments into Europe

Date announced	Investor	Country	Investment	Value (€bn)
Aug 2022	CATL	Hungary	Battery plant	7.6
Jun 2021	Envision AESC	France	Battery plant	2.0
May 2021	Envision AESC	UK	Battery plant	0.5
Nov 2020	SVOLT	Germany	Battery plant	2.0
Jun 2018	CATL	Germany	Battery plant	2.0

Market perspectives

- **Europe has become a top investment destination** for Chinese investments in the LIB value chain
  - This is part of China's global push to capture key inputs and global market share for its EV sector
  - Investments are targeted towards sectors where **Chinese private firms are already highly competitive**
  - Deals are executed mainly via **greenfield investments**
- There is a growing **shift in focus by Chinese investors from upstream activities** (e.g. minerals deal in DRC, Zimbabwe, Indonesia, Chile, etc) **to midstream activities** which involve setting up battery gigafactories close to EV final demand markets such as Europe
- **Europe remains open to Chinese investments**, unlike the US which is pushing for developing its own domestic battery supply chains through initiatives such as the Inflation Reduction Act

Source: Mercator Institute for China Studies (MERICS)

Investment flows (3/3)

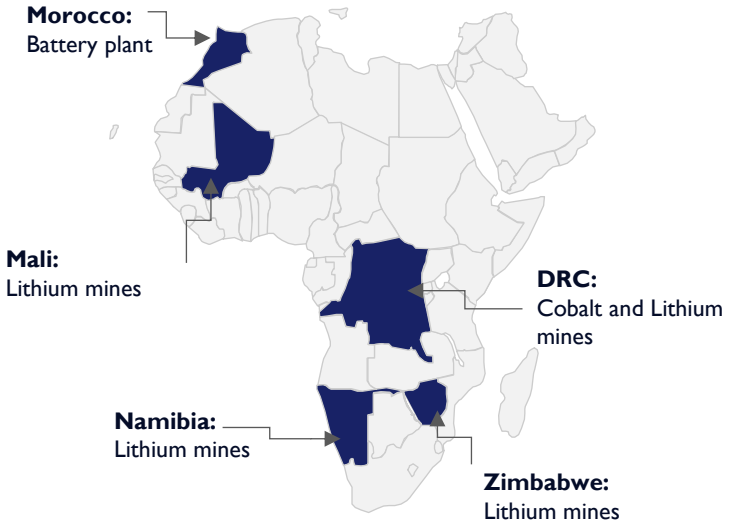
African countries are well positioned in attracting investments to do with local upstream mining activities, but there is also an opportunity to act as a local nearshoring region to serve the European LIB supply chain

Typical divers of investment into the LIB value chain

	Africa's relative attractiveness
A robust domestic EV sales outlook	
Availability of LIB / EV production incentives	
Availability of local upstream mining of critical LIB raw materials	
Strategic location as a nearshoring destination for large EV markets	

Low Medium High

Selected Chinese investments into Africa's LIB value chain (2022-23)



- Africa is attracting investments mainly into its **upstream mining activities** as there is an abundant supply of critical LIB raw materials on the continent
- **Chinese firms are the main source of investments into Africa**; Chinese mining and battery companies are mainly investing in lithium mines in Africa as they look to secure raw materials for their LIB production expansion.
- Investment into the **first LIB gigafactory in Africa** was announced in **Morocco** in June 2023 as Africa also positions itself as a suitable **nearshoring destination** for EV markets

Source: BMI, S&P Global, Press articles

4

Expansion of battery production capacity in Europe (1/3)

European countries are actively looking to expand their battery production capacity to meet growing domestic demand for LIBs; The Critical Raw Materials Club is a forum led by the EU where resource-hungry and resource-rich countries collaborate in diversifying critical raw materials value chains

The EU Critical Raw Materials Club

	Resource-hungry countries	Resource-rich countries
Commitments	• **Investments, technical assistance and other resources** to support resource-rich countries in moving up the value chain and developing downstream capacities • **Technological transfers** and research and development • **Fair prices** for raw minerals through off-take agreements and tailored trade deals	• **Free trade** in critical raw materials within the club, extracted and processed in **compliance with ESG** standards • **Guaranteed supply**, with no export bans or nationalisation of critical raw materials
Benefits	• Access to a **secure and sustainable supply** of critical raw materials	• **Fair prices** for critical raw materials • **Investment, funding, technical assistance, and know-how** for domestic downstream capacity development • Industry development, **skills development**, job creation and increased tax revenues
Member countries	• EU • Discussions still underway with US and other resource-hungry countries	• Namibia, Zambia • Rwanda, DRC, Uganda, Tanzania and South Africa expected to join

Source: European Council; Press articles

4

Expansion of battery production capacity in Europe (2/3)

Poland and Hungary are at the forefront of attracting investments in gigafactories and securing local capacity for LIB production in Europe

Increase in LIB production capacity expected from Europe in 2024-2030

Poland

- Poland is currently the **largest producer of LIBs outside of Asia** with a production capacity of ~73GWh having experienced robust growth since The Polish Alternative Fuels Association (PSPA) started actively pursuing investments in this sector
- Poland has **attracted investment** from some of the largest LIB producers, including South Korea's **LG Energy Solution**, and Swedish ESS battery manufacturer **Northvolt**
- OEMs such as **Mercedes Benz** and **Volvo** have also opened technology centres in Poland focused on developing EVs

Hungary

- Hungary is well positioned as a leading battery manufacturing hub for Europe; There is high government support to attract investments into gigafactories and production of EV battery components
- Recent investments include:
  - **Chinese companies CATL** and **Huayou Cobalt** who set up greenfield operations in Hungary. As part of the investment, the Hungarian government offered CATL a **~€800m incentive package** consisting of grants, tax breaks and infrastructure
  - **BMW announced** plans to set up battery assembly operations in Debrecen, the same city that will accommodate the 100GWh CATL plant
  - **EcoPro BM** and Huayou Cobalt announced that they will set up CAM plants to meet a rapid rise in demand from battery plants that are due to begin operations

Source: BMI, Polish Alternative Fuels Association (PSPA)

4

Expansion of battery production capacity in Europe (3/3)

Germany and UK are looking to secure investments in gigafactories, whilst Sweden, Norway and Finland are focusing on expanding their anode material production hubs for the European market

Increase in LIB production capacity expected from Europe in 2024-2030

Germany

- Largest EV market in Europe
- Recent investments include:
  - Chinese company **CATL** chose Germany for its first battery production plant outside China
  - Chinese company **SVOLT Energy Technology** announced investments of up to €2bn to build a cell production facility as well as a module and pack factory in the south-western German state of Saarland

UK

- The UK Government is looking to secure investments in gigafactories. The UK already hosts several large OEMs including Nissan, Jaguar Land Rover, Stellantis, BMW MINI and Toyota
- Recent investments include:
  - **Nissan** announced a **£2bn investment plan to expand its UK EV hub** in Sunderland to build its Qashqai and Juke EV models as well as a new EV battery gigafactory with **Envision AESC**
  - **Jaguar Land Rover's** owner Tata announced plans to build a **£4bn EV battery gigafactory** in Somerset

Sweden, Norway & Finland

- Sweden, Norway and Finland are focusing on **anode material production hubs for the European battery supply chain**
- Recent investments include China's **Putailai** announced plans to invest ~$1.5bn in Zichen Technology (**Sweden**) AB to build Europe's largest factory for anode manufacturing
- China's **Ningbo Shanshan** announced and investment of ~$1.3bn to build an anode factory in **Finland**

Source: BMI, Press Articles

4

Deep-dive on Poland (1/2)

Strong government support, the availability of highly skilled engineers and its cost competitiveness have positioned Poland as a leading player in the European LIB supply chain and as a gateway to the wider EU market

Overview

- The Polish government has a **strategy to become the centre for a European local-for-local integrated battery materials supply chain**
- Poland is already **renowned for its automotive parts production** in Europe and is now the **2nd largest LIB supplier in the world** after China
- Poland is an integral part of strategic moves by European OEMs to **bring as much of the EV production process to their domestic market**

Strengths

- **Strong national policy framework and support from the government** to attract investments into the sector – e.g. through enabling policies, subsidies, tax incentives, availability of free trade zones and cash grants of 5-25% of total investment costs
- **Availability of a highly educated and skilled workforce**
  - Poland's major cities host technical universities that are producing highly skilled engineers
  - Poland has also acquired significant critical knowledge through the investment by LG Energy solutions
- **Infrastructure, logistics and supply costs** – Its central European location gives Poland easy access to major European transportation hubs and Baltic Sea ports
- **High manufacturing capacity and economies of scale** gained historically from its role as the centre of automotive parts production in Europe
- **Cost competitive** on labour and infrastructure costs

Challenges

- **Increasing global competition** in the LIB supply chain, including threat of the impact of the US Inflation Reduction Act, which may act as a pull factor for investors from Europe to the USA
- **Lack of domestic capacities for raw battery materials** – There is a need to procure raw materials from outside Poland sustainably, taking into account environmental, ethical, and social considerations
- **Enhancing R&D in recycling and second-life projects** and in new battery cell chemistries to ensure a more sustainable supply of materials for battery production
- **Relatively long lead times** from investment announcement to commercial production, of ~4 years, compared to China which has a lead time of less than two years

Outlook

- Poland is looking to **double its production capacity by 2027**, surpassing a total production capacity of over 200 GWh

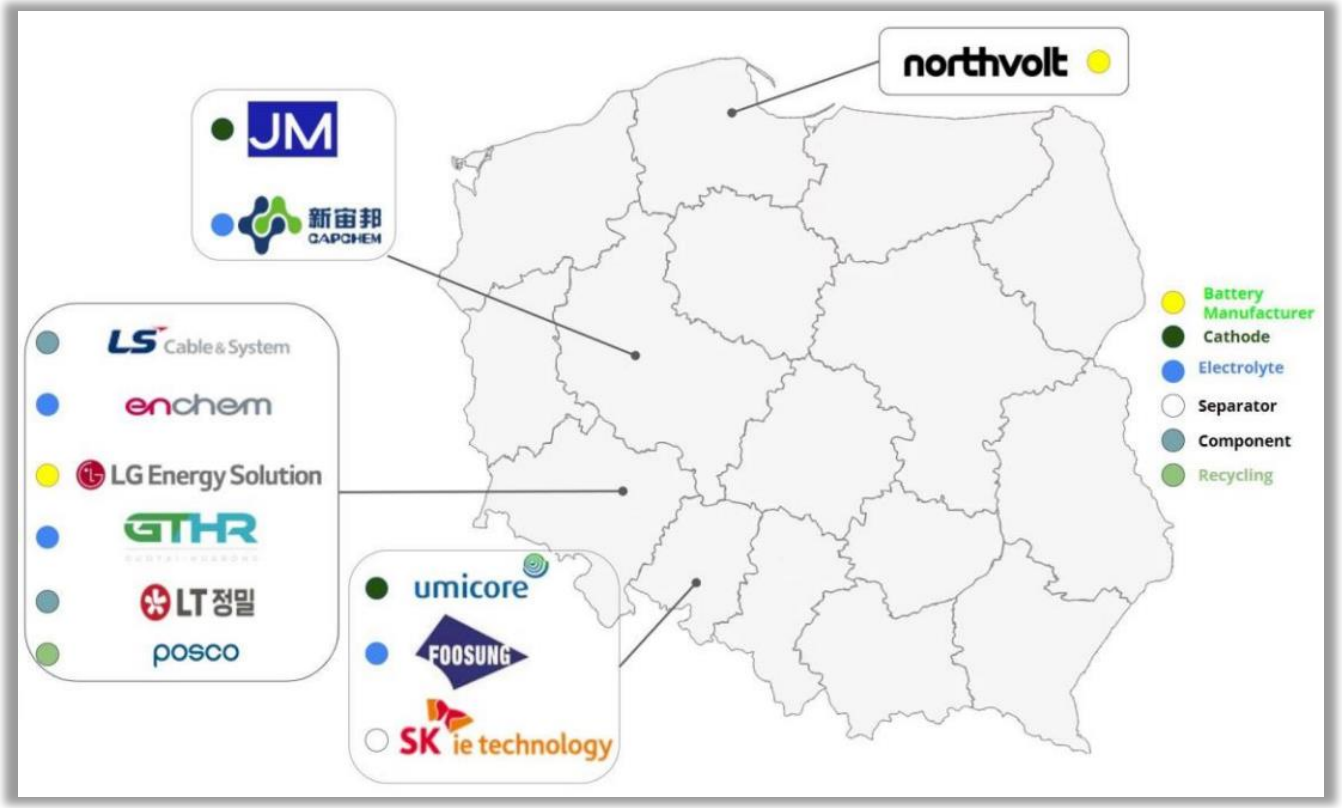
Source: Polish Alternative Fuels Association (PSPA), emerging-europe.com

4

Deep-dive on Poland (2/2)

Poland has attracted interest mainly from Asian greenfield investors in the LIB value chain. Investors are housed in special economic trading zones, creating an enabling environment from which to operate

Selected investments*



Investor	Country of origin	Investment value	Investment overview
SK Hi-Tech	South Korea	€840m	• Greenfield plant which produces separators
SK Nexilis	South Korea	€650m	• Greenfield plant which produces copper foil
LG Energy Solution	South Korea	€380m	• Largest LIB production centre in Europe
Northvolt	Sweden	€165m	• Battery systems assembly factory
Capchem	China	€50m	• Greenfield plant which produces electrolytes
Umicore	Belgium	n/a	• Greenfield CAM plant

* Not exhaustive
Source: Polish Alternative Fuels Association (PSPA); PM Group

5

Evolution in battery chemistries and emerging battery technologies (1/2)

LIB Precursors are based on various chemistry components, each with different features and implications for their cost, capacity and performance. NMC and NCA are the most dominant chemistries for passenger EVs, whilst LFP is the dominant chemistry for commercial EVs and ESS

● High ○ Low

Chemistry	Overview	Energy density	Cost	Safety	Expected evolution
NMC Nickel-Manganese-Cobalt	• **Most prevalent** battery chemistry and fastest growing segment • Balanced mix of cost, energy density, power and safety; Typically for **high energy use cases** • Includes variations depending on the ratio of nickel to manganese to cobalt, – e.g. NMC 622 (6 parts nickel, 2 parts manganese, 2 parts cobalt); NMC 811 (8 parts nickel, 1 part manganese, 1 part cobalt) – The higher the percentage of nickel the higher the energy density but the lower the safety of the battery • Dominant chemistry for **passenger EVs**, especially in **China and Europe**	●	◕	◕	→
NCA Nickel-Cobalt-Aluminium	• Very high energy density and power • Dominant chemistries for **passenger EVs in the US**	●	◕	◑	→
LFP Lithium-Iron-Phosphate	• Relatively low energy density, longer life span, higher safety, and low-cost (as does not contain nickel and cobalt, which are high-cost materials) • Dominant chemistry for e-buses, commercial vehicles and lower range passenger EVs, especially in **China** (low-cost entry-level vehicles) • Also popular for **ESS**	◑	◑	●	↗
LMO Lithium-Manganese-Oxide	• Low-cost (as does not contain nickel and cobalt, which are high-cost materials) • Used as a cheaper alternative for high volume EVs (mainly commercial) • Was popular in early commercial EVs but now seeing a gradual phase-out in new EVs	◔	◔	◕	↘

Source: BloombergNEF, McKinsey Battery Insights, BMI, Subject Matter Experts

5

Evolution in battery chemistries and emerging battery technologies (2/2)

The industry is exploring new, more efficient battery technologies with a view to gradually move away from lithium-based batteries in the long term; There is growing focus on smaller battery packs, faster charging and the use of different anode materials

- China's **CATL** announced that it will reach mass production of Sodium-ion batteries in 2023
- China's **BYD** announced that it would start massively producing EVs with sodium batteries for its e-hatchbacks
- Sweden's **Northvolt** announced the launch of its commercial sodium-ion battery for ESS in Europe in Nov '23

Emerging technology	Overview	Expected evolution
Post-lithium batteries	**Sodium-ion batteries** • Still in development, but may become more mainstream in the medium-term • Use sodium instead of lithium, and are also free from nickel, cobalt and graphite; The cathode is based on combinations of sodium, iron and cyanide (Prussian white material) • **Pros:** Relatively cheaper than LIBs given the abundance and low price of sodium; Safer (better low temperature performance); Faster charge times; More environmentally friendly • **Cons**: Lower energy density; Lower attainable voltage • **Likely applications**: ESS and low performance vehicles	
	Magnesium or potassium-ion batteries • Use of magnesium or potassium instead of lithium • **Pros:** Cheaper than Lithium-ion but not as cost effective as Sodium-ion • **Cons**: Low performance and safety record • **Likely applications**: specialized applications e.g. large-scale ESS	
Solid state lithium-ion batteries	• Gaining a lot of focus from the largest OEMs • Replaces the liquid electrolyte in a battery cell with safer solid materials such as tin (solid electrolytes) • **Pros:** Significantly higher performance ranges; Faster recharge times; Safer; Lighter (by reducing the weight of the battery you gain more mileage out of it) • **Cons**: High production costs; Can be sensitive to low temperatures • **Likely applications**: Passenger EVs	
Battery cell integration	• Development of **Cell to Body (CTB)** and **Cell to Chassis (CTC)** technologies which **reduce the number of components**, and improve the overall **space utilization and performance of EVs**; Puts further emphasis on the **need for battery manufacturers to be co-located with OEMs** • CTB technology connects the battery cover to the body of the car, whilst CTC technology integrates the battery cells directly into the vehicle chassis	

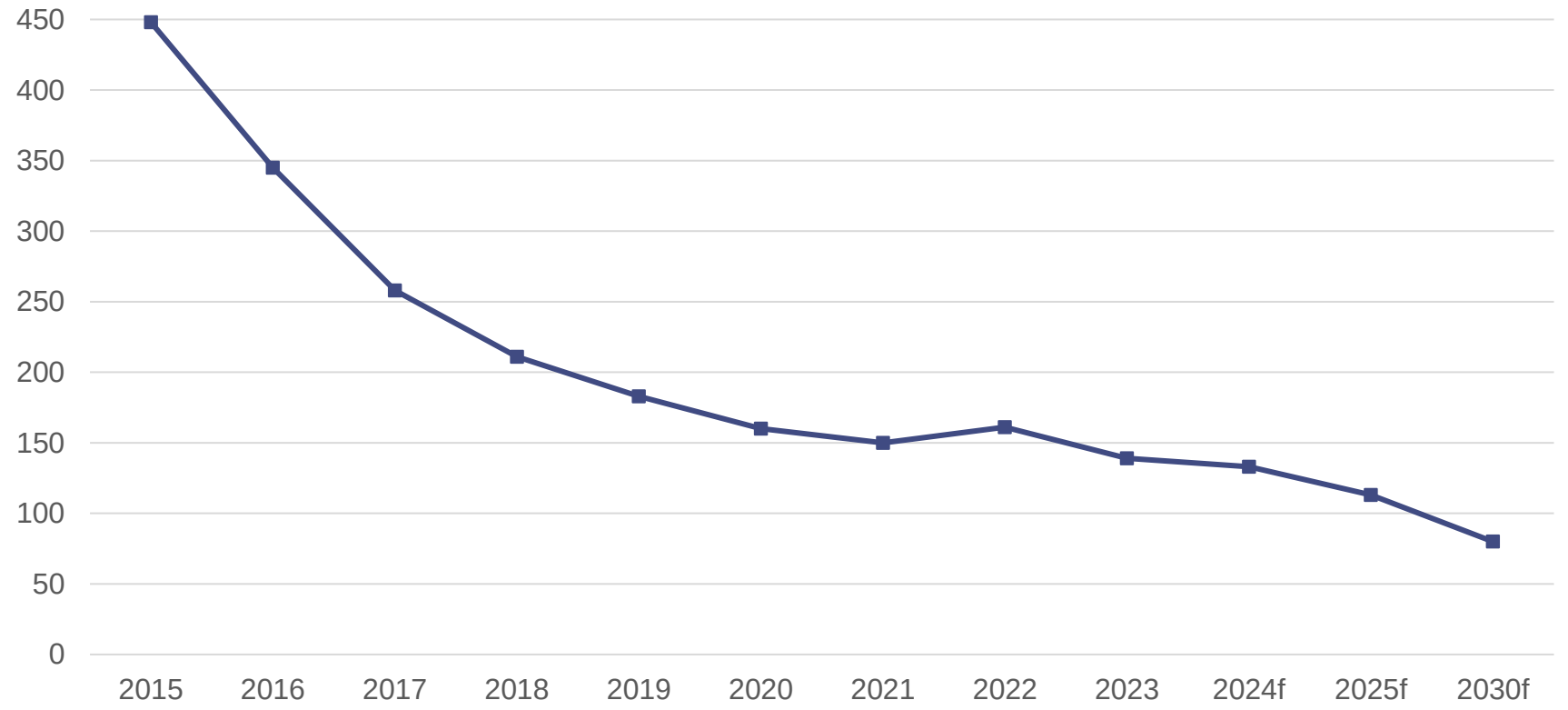
Source: BloombergNEF, McKinsey Battery Insights, BMI, Subject Matter Experts

6

LIB price trends

The price of LIBs has been coming down, driven by economies of scale and technological innovation, and is expected to continue to fall with improvements in technology in the medium to long-term

Volume-weighted average LIB price, $/kWh



Market perspectives

- The average price of LIBs has been **gradually falling** in response to several factors including:
  - Increased production capacity in China
  - Improved cell chemistries and designs
  - Gradual switch to LFP chemistry which is a lower-cost cathode chemistry
- The **price is expected to continue to fall to 2030** with a greater focus on economies of scale, better pack designs and additional production capacity from Europe and the US

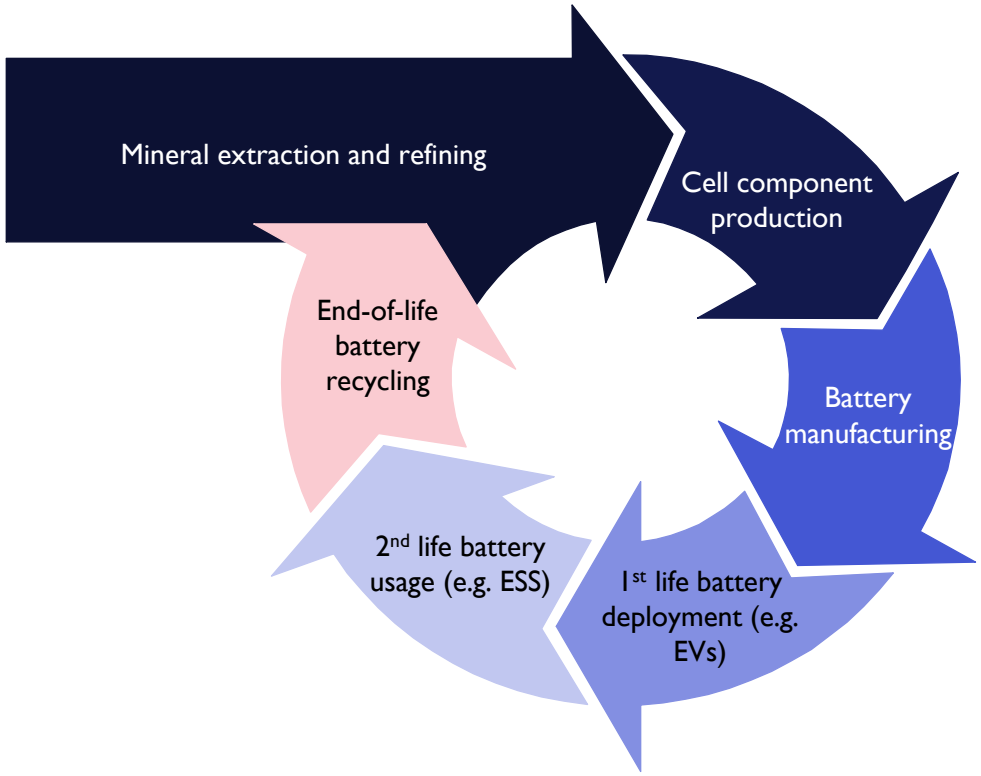
Source: BloombergNEF, iea

7

Greater focus on battery recycling

There is a greater emphasis on battery recycling by OEMs and battery manufacturers in order to enhance the sustainability of LIBs and help address issues of raw material scarcity. The industry is moving from a linear to a circular value chain where used materials are repaired, reused, or recycled

Illustrative circular economy battery value chain



Market perspectives

- There is a **greater emphasis on battery recycling** by OEMs and battery manufacturers to **enhance the sustainability** of LIBs and help **address issues of raw material scarcity**
- Several governments have introduced **battery recycling regulations** which require OEMs to have **minimum levels of recycled materials in their EV batteries** - E.g. the EU Battery Recycling Directive
- The industry is focused on the **recovery of metals** such as lithium, nickel and cobalt once batteries have reached their end-of-life, as well the **repair, reuse and recycling** of used materials
- European and US industry players are actively exploring new business models for the recycling segment as recycling could potentially help to **localize battery supply chains** in the long-term

Source: BMI, McKinsey Battery Insights, Volta Foundation Annual Battery Report

8

Regulatory developments

The regulatory landscape is complex with multiple regulatory bodies at global, regional and national levels; EU and US regulations encourage localizing production of LIBs to their respective regional markets

Selected regulations impacting LIBs

Regulation	Applicable jurisdiction	Remarks
EV battery safety guidelines	Global	• Extensive and complex guidelines relating to all aspects of battery use • Guidelines vary regionally between Europe, China, Japan, and the US • Includes specific standards from International Standards Organization (ISO), International Electrotechnical Commission (IEC), SAE International (SAE), and GB/T Chinese national standards
EU Battery Regulations	EU	• Requires EV batteries to be collected and recycled in full • Sets mandatory recycling content in new LIBs (65% by average weight by Jan 2025, and 70% by Jan 2030)
Battery Passport Regulations	EU	• Ensures ethical sourcing and encourages transparency, localization and sustainability of batteries used in the EU • From Jan 2026, all EV batteries need to be equipped with a unique battery passport which records information about the origins of the battery's components, its sustainability metrics and performance levels
European Critical Raw Materials Act (CRMA)	EU	• Sets out comprehensive measures and targets for EU regional processing of critical raw materials • Includes the establishment of a central raw materials buying agency
US Inflation Reduction Act (IRA)	US	• Aims to localize production of LIBs within the area covered by its North and South American free trade agreements • From 2027, for an EV to be tax-credit eligible, 80% of the market value of critical minerals in its battery must be sourced domestically or from US free-trade partners

The US IRA has effectively shut out Chinese suppliers from the US market. Chinese manufacturers are therefore more likely to target their investments into Europe

Zoom on EU's Rules of Origin for European LIB production

- In 2020 the European Commission published new battery import requirements into the EU (Rules of Origin):
  - From 2024 OEMs will need to source the majority of its batteries and materials from within the EU (~55% local content)
  - From 2027 65% of the battery cells in EVs must contain EU or UK originating materials
  - From 2024 to sell into the EU suppliers will need to establish a European operations base

Source: European Battery Alliance (EBA), European Parliament, Press articles

Section 3

Supply Dynamics

SECTION 3.1

Global supply trends

Overview of global supply trends for LIB critical raw materials

Key trends

01

Resource scarcity

02

Top producers of key LIB metals in Africa

03

Developments in the price of key LIB metals

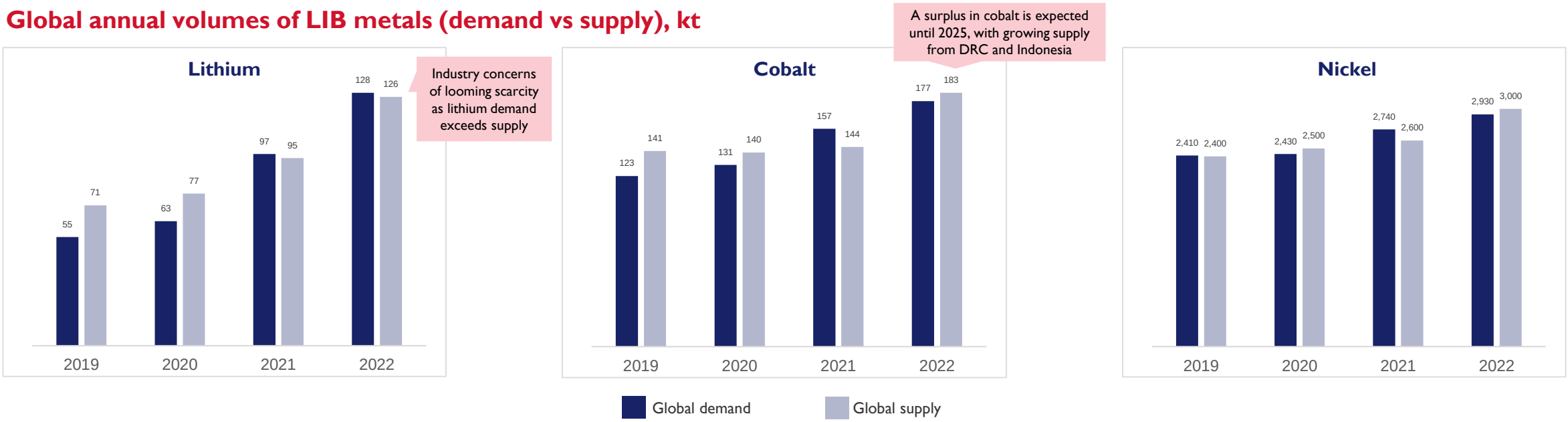
04

Greater focus on ESG compliance

Resource scarcity

There could be a 55% gap in global demand vs supply of lithium in 2030 if no further mining projects are developed*. Similarly, there could be a slight undersupply (~8% below demand) of nickel in 2030 given the current pipeline of mining projects

Global annual volumes of LIB metals (demand vs supply), kt



Market perspectives

- The extraction of critical LIB metals **needs to increase** in order to meet growing global demand for clean energy
- For example, lithium demand exceeded supply in 2021 and 2022, raising concerns of looming shortages for the commodity for LIBs
- Given the looming shortages, the LIB industry is actively pursuing the **development of new post-lithium battery technologies** in order to minimise the risk of supply chain disruptions in the long-term

*According to McKinsey MineSpans, 2022
Source: iea, S&P Global Commodity Insights, McKinsey

Top producers of key LIB metals in Africa

Africa is well endowed with the key resources required for the production of LIBs which presents opportunities for potential collaboration between African countries in the battery value chain

Top producers of LIB metals in Africa

	Cobalt	Copper	Graphite	Lithium	Manganese	Nickel
Burundi	✓	✓				✓
DRC	✓	✓		✓	✓	
Gabon					✓	
Ghana				✓	✓	
Ivory Coast					✓	✓
Madagascar	✓		✓			✓
Mali				✓	✓	
Mozambique			✓			
Namibia		✓	✓	✓	✓	
Rwanda				✓		
South Africa	✓	✓		✓	✓	✓
Tanzania			✓			✓
Uganda		✓	✓			
Zambia	✓	✓	✓		✓	✓
Zimbabwe	✓	✓	✓	✓		✓

Source: AfDB, United States Geological Survey (USGS)

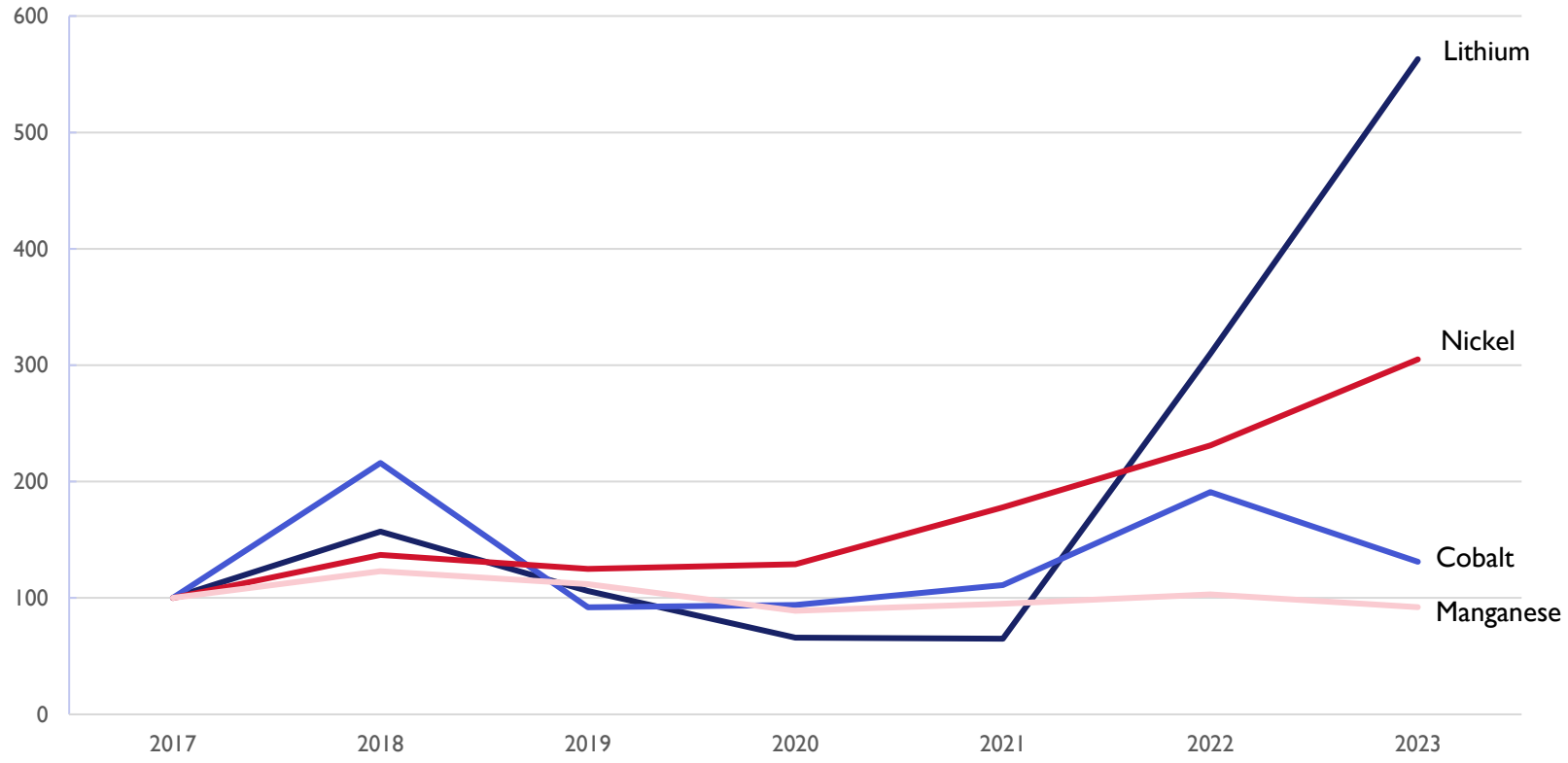
Opportunities for country-level collaboration

- **Zimbabwe** is a key player in the supply chain with significant high grade **lithium** reserves as well as **cobalt** and **nickel**
- The **DRC** contains the largest reserves of **cobalt** in Africa
- **South Africa** hosts ~80% of the world's **manganese** resources and is also the largest producer of **nickel** as a by-products of its platinum group metals
- **Zambia** has the largest reserves of **copper** in Africa
- **Mozambique** has Africa's largest **graphite** reserves which can be used in the development of Anode Active Materials

Developments in the price of key LIB metals

There has been a rise in the price of lithium since 2017 as demand exceeded supply, whilst there has been downward pressure on the price of cobalt mainly driven by excess supply

Price index of selected LIB metals (2017=100)



Market perspectives

- There was a pandemic-related fall in metal prices in 2020-2021 followed by a **steep increase** in 2022 as post-pandemic demand exceeded supply
- **Sharp rise in lithium price** in 2022 and 2023 mainly fuelled by growing demand which is exceeding supply
- Growing demand for high nickel chemistries such as NMC is **driving up the price of nickel;** However **increased supply of nickel** from Indonesia and China may balance out the demand and supply dynamics
- A gradual decline in the use of **cobalt** in LIB chemistries is anticipated and the expected surplus is putting **downward pressure** on the price of cobalt

Source: iea, S&P Global Commodity Insights

4

Greater focus on ESG issues

There is a greater focus on ESG issues across the full value chain of the LIB industry with regulators introducing measures to ensure ESG compliance

ESG challenges across the supply chain

Environmental	• Land degradation • Resource drainage • Land, water and air pollution • High carbon emissions
Social	• Child labour and gender equality issues • Health and safety • Fair pay and working conditions • Disruption to local communities
Governance	• Wars and conflicts • Bribery and corruption • Non-compliance with regulations • Tax evasion

Market perspectives

- Growing concerns around issues such as **conflict minerals, child labour and unfair working conditions** have prompted industry regulators to pay **greater attention to ESG compliance**
- The EU introduced **new battery regulations** that require due diligence of supply chains to assess **ESG risks**, and the need for transparency in the sourcing of LIB metals
- Newer battery technologies such as sodium-ion batteries are perceived to have the potential to become more **environmentally friendly alternatives** to LIBs in the future

Source: McKinsey, S&P Global

Risks and challenges associated with the supply-side

The LIB value chain is generally associated with high levels of risk which include supply chain, technical, operational and ESG risks

Risk / Challenge	Description	Risk rating
Supply chain risks	• Scarcity and potential shortages of critical raw materials; There is a **need to build a diversified and resilient supply-chain** – High risk of a substantial shortfall of lithium in the medium to long term; Supply levels will also be stretched for nickel and cobalt – Long lead times in extraction of critical raw materials; It can take three years from exploration to setting up a full-scale mining plant for lithium	
Technical challenges	• Risk of **technological obsolescence** as battery chemistries evolve and new battery technologies emerge. A high level of technical agility is required • **Long lead times** and delays in the construction of gigafactories • **Shortages of skilled labor** and technical know-how	
Operational risks	• Challenges associated with managing **high capital and operational costs** in LIB manufacturing processes, especially in setting up high volume production	
ESG risks	• There are significant **environmental and social risks** associated with LIBs across the entire chain, including: Ethical sourcing; High carbon emissions associated with LIB production; and Human rights issues in several mining operations • Burden of compliance with a **complex regulatory landscape** at global regional and national levels	

High Medium Low

Source: BMI, iea, Subject Matter Experts

SECTION 3.2

Rwanda's mining sector

Overview of Rwanda's mining sector

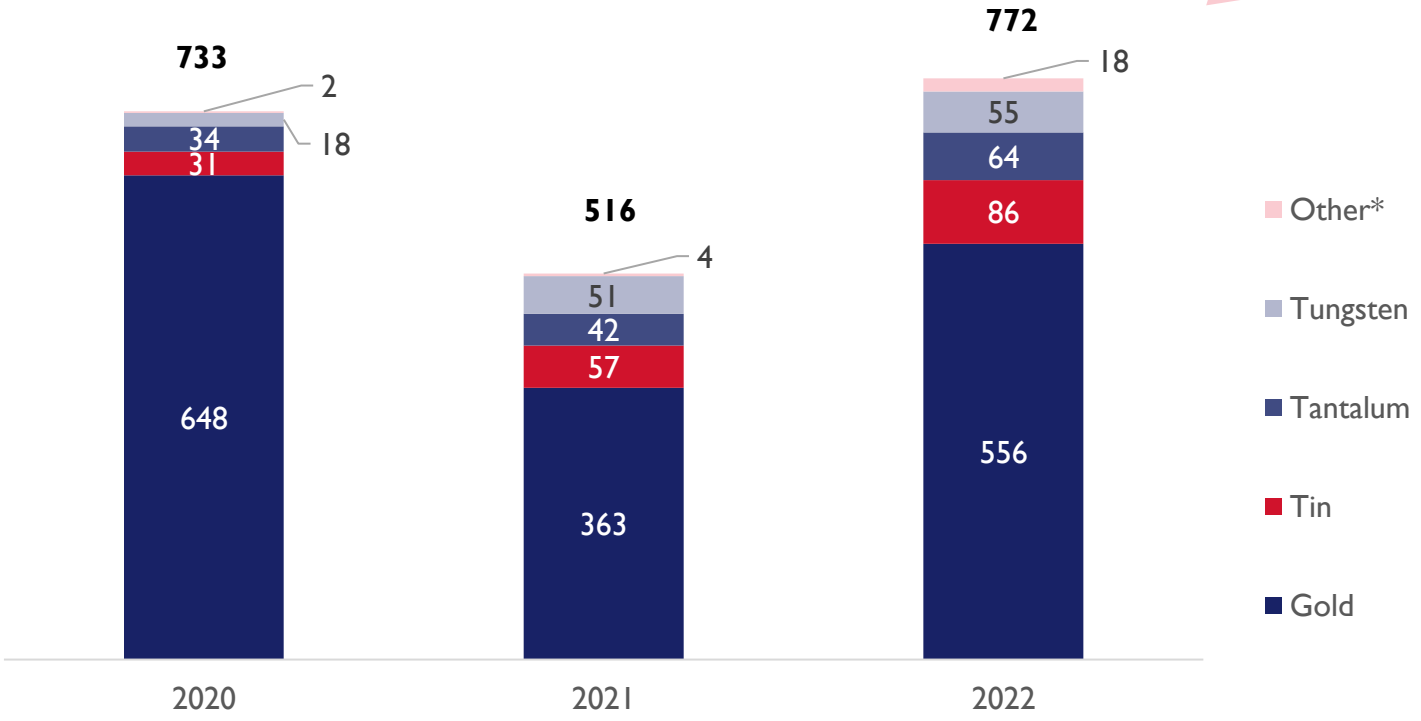
Rwanda's main mineral deposits include gold, the 3Ts and Rare Earth Elements. There have also been recent discoveries of lithium-bearing minerals with opportunities currently being explored

Overview

- Main minerals mined in Rwanda are gold and Tin, Tantalum and Tungsten (3Ts). Rwanda is **one of the largest producers of 3Ts globally**
- Main export markets include Asia (~51%), EU (~25%) and the Middle East (~24%)
- **Lithium** has started being explored and extracted in Rwanda (since 2020) and there is **potential for significant discoveries**
- There are known **nickel deposits in the region** with the Eastern parts of **Rwanda having potential**
- The region also hosts **Rare Earth Elements (REE)** deposits with known REE mineralization in Rwanda
- Rwanda's mining sector is **growing** with the government aiming to increase its contribution to GDP from ~1% to ~6%

Value of Rwanda's mineral exports by commodity ($m)

Mineral exports are forecast to reach **$1.5bn by 2024** according to Rwanda's National Strategy for transformation



*Other includes Lithium, Gemstones and Beryl
Source: Rwanda Mines, Petroleum and Gas Board (RMB), Rwanda's 7 Year Government Programme: National Strategy for Transformation (NST1) 2017–2024

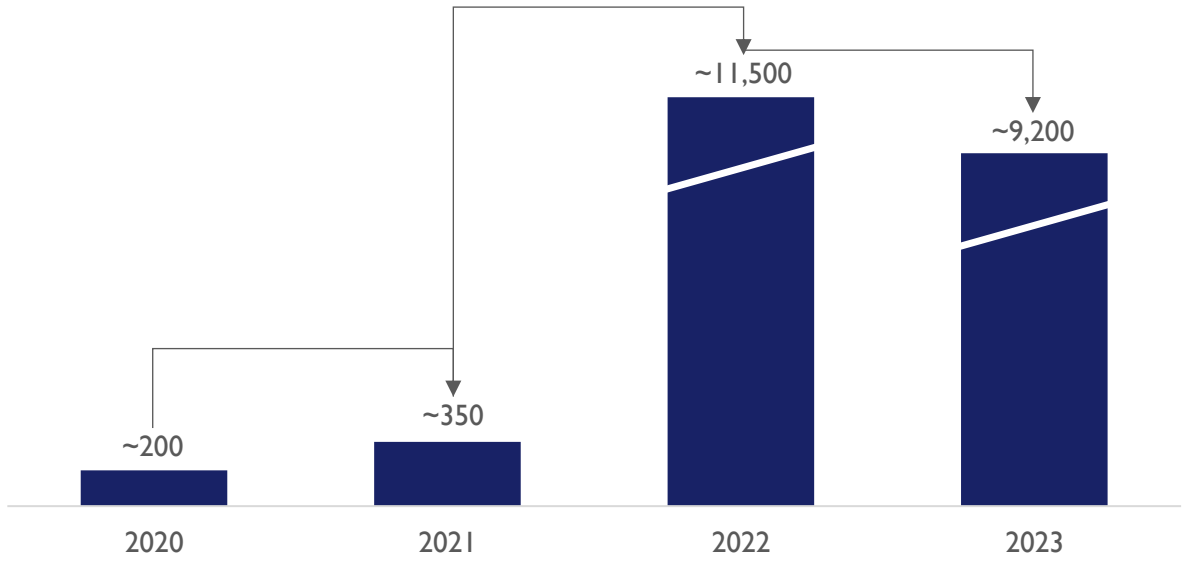
Lithium occurrences in Rwanda

There are known occurrences of lithium-bearing minerals in Rwanda and the government has granted licenses to selected investors for further exploration and extraction

Overview

- There are **known occurrences of high-grade lithium-bearing minerals** (Amblygonite, Spodumene and Lepidolite) in Rwanda, with the **potential for significant discoveries** with more focused exploration
- RMB has granted **exploration licenses** to selected investors; Examples include
  - **Aterian** plc entered into a JV with **Rio Tinto** in Aug 2023 to fund and operate lithium exploration in Rwanda
  - **Trinity Metals** is actively pursuing lithium exploration in Rwamagana District in the Eastern Province
  - **Power Resources Group** is exploring Lithium-Caesium-Tantalum pegmatite deposits in the Western Province
- A private company has been engaged to start the process of **establishing a lithium processing plant in Rwanda** as the government recognizes the need to export lithium carbonate instead of raw lithium ore

Volume of lithium exports (2020-2023, tons)



- Prior to 2022, most lithium bearing minerals in Rwanda were being put to waste; There were only a few companies involved in extracting and exporting lithium ore
- There was a significant increase in lithium export volumes in 2022 as more companies became aware of the opportunity and began to proactively extract lithium ore for exports
- Export volumes expected to continue to increase with greater focus on the lithium sector in Rwanda

Source: Rwanda Mines, Petroleum and Gas Board (RMB), Subject Matter Experts, Press articles

Private sector companies operating in Rwanda's mining sector

Rwanda's mining sector is home to several private sector investors focused on exploration, development and value addition of critical raw materials. There are currently three refinery plants in Rwanda - Gasabo Gold Refinery (gold), LuNA Smelter (tin) and Power-X (tantalum)

Gasabo Gold Refinery Ltd

- Privately-owned company **specializing in gold and silver refining** on behalf of local and international clients
- Operates from the Kigali Special Economic Zone
- Receives unrefined gold from various **local and regional mines.** The unrefined gold undergoes melting, testing and purification processes
- Has capacity to process 8-10 tons of pure gold per month

LuNa Smelter

- East Africa's only **tin smelter**
- Established in 2018 as a JV between Luma Investment Group of Poland (75%) and State-owned Ngali Holdings (25%)
- Initial capacity of 380tpm of cassiterite
- Products include tin ingots, tin drosses, tantalum concentrate and tantalum slag (as by-products)
- **Products are exported to LuNa's existing client base in Europe**

Power Resources Group

- UK company founded in 2015 to secure critical metals needed in Western based manufacturing processes
- **Backed by Talanton**, a US-based impact investor, since 2021
- Producer of **refined tantalum and niobium**, and is developing a Ta-Nb refinery in the Bugesera industrial zone near Kigali under its **Power-X** subsidiary
- Operations also include **exploration of Lithium-Caesium-Tantalum (LCT) pegmatite deposits** in the Western Province

TRINITY METALS

- Established in **May 2022** following the consolidation of three companies: Piran Rwanda Ltd, Eurotrade International Ltd and Rutongo Mines Ltd
- **Equity backed by Techmet**, a UK private industrial company
- Strong track record of mining and exploration of **tin, tungsten and tantalum** in Rwanda
- Actively involved in **lithium exploration** in Rwamagana District in the Eastern Province - currently exploring the scale of lithium and evaluating extraction options

Aterian plc

- London (LSE) listed mining company with operations in Rwanda and Morocco
- Operates in Rwanda under its subsidiary **Eastinco Limited**
- Engaged in **mineral exploration of critical metals in Rwanda**, with a focus on **tantalum, niobium, tin and lithium**
- Entered into a **JV with Rio Tinto** in Aug 2023 to fund and operate **lithium exploration** in Rwanda
- Aims to develop a **metal trading business in Rwanda** in the longer term

Source: Company websites, Press articles

Rwanda's regulatory and policy frameworks in the mining sector

Rwanda has a robust legal and regulatory framework that governs the mining sector, with strong government support and a willingness to improve the sector. Recent mining code changes have seen Rwanda implementing international regulatory frameworks which are attractive to foreign investors

Key regulatory bodies in the mining sector

RMB Rwanda Mines, Petroleum and Gas Board	Responsible for the development of policies, laws, and regulations in the mining sector, and the implementing the national mining policies and strategies
RDB Rwanda Development Board	Responsible for supporting sustainable economic growth and development
REMA Our Environment Our Future	Responsible for implementation of environmental policies and laws

Mining policy and code objectives

- Promoting scale and sustainability
- Facilitating the transition to modern and efficient mining methods
- Encouraging greater foreign direct investment
- Improvement in environmental, social and health and safety practices
- Promoting value additive processing to increase revenue
- Promoting domestic industry to become a regional hub for mineral services

- The regulatory and policy frameworks define **ownership rights, licensing procedures, environmental standards** and royalty systems
- Rwanda is also a member of the International Tin Supply Chain Initiative (**ITSCI**), an international programme for Responsible Mineral Supply Chains

Source: Rwanda Mines, Petroleum and Gas Board (RMB), Subject Matter Experts

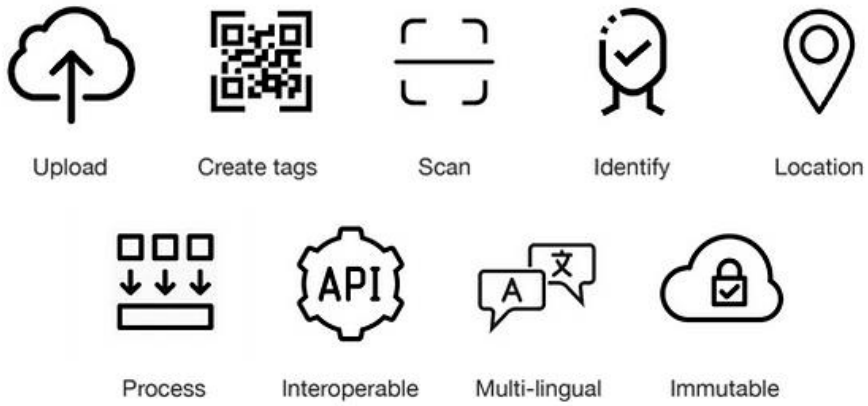
Mineral transparency initiatives

100% of Rwanda's minerals are traceable from their mine site up to their export point. Minerals are traceable through a digitalized blockchain tagging system which complies with international regulatory requirements

Rwanda's mineral traceability tagging system

- Rwanda adheres to the **Dodd-Frank "conflict-minerals" Act**, with **100% of its minerals being traceable from their mine sites up to their export point**
- Mineral traceability in Rwanda use two schemes: International Association (ITA) and RCS Global
- Rwanda's mineral traceability tagging system is a **certification scheme** that tracks raw materials extracted in Rwanda right along the supply chain, from mine to shelf
- Mineral ores are tagged at their production site before being exported
  - The tagging system is **digitised via blockchain technology** developed by UK company **Circulor Ltd**
  - Miners in Rwanda use a **mobile app** to tag their mineral ores before they are exported
  - Each sealed bag containing the minerals has a **unique code identifying its origin**
- Whilst the tagging system is mainly aimed at the 3Ts under the **ITSCI's traceability for conflict minerals**, it can also be applied to the entire Rwandan mining sector to identify the source of minerals exported

Blockchain technology interface



Source: Subject Matter Experts, Press articles, circulor.com

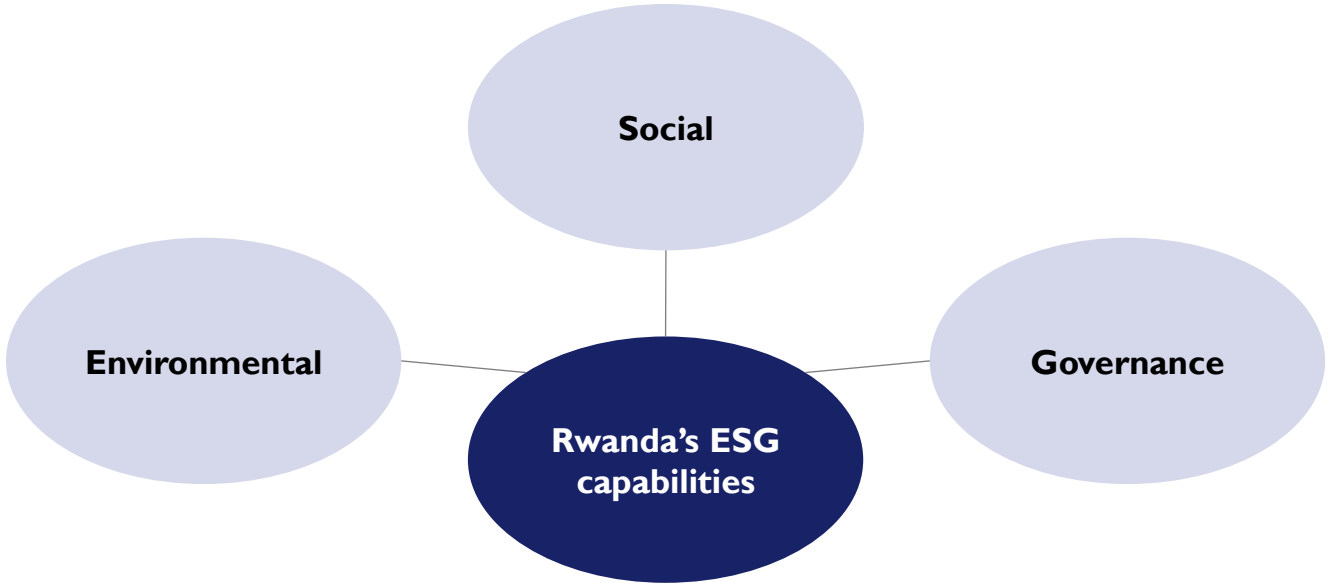
ESG capabilities in the mining sector

Rwanda has robust ESG capabilities in the mining sector with relevant policies developed, implemented and monitored via the Rwanda Environment Management Authority (REMA) and Rwanda Mines, Petroleum and Gas Board (RMB)

ESG capabilities in the mining sector

- **RMB** monitors compliance of mining operations with the provisions of the law to strengthen **social and economic benefits**
- It is also involved in **community engagements** and ensures indigenous people's rights are protected through **social welfare and inclusive value creation**

- The Rwanda Environment Management Authority (**REMA**) is responsible for **implementing environmental policies** and laws
- This includes conducting environmental impact assessments and developing mining practices that minimize negative effects of mining extraction



- **RMB** is responsible for the development and implementation of policies, laws, and regulations in the mining sector
- Policy frameworks define **ownership rights and licensing procedures**
- All mining activity is **subject to licencing and permits** issued by RMB and is required to **adhere to relevant local and international laws**

Source: Rwanda Mines, Petroleum and Gas Board (RMB)

Section 4

Competitive Analysis

SECTION 4.1

Selected country case studies

DRC/Zambia case study (1/2)

The DRC/Zambia MOU is widely supported by key institutions in Africa, including the AfDB, as it is viewed as a first step in the development of a pan-African value chain for EV batteries

Overview

- In Dec 2022, the USA signed a trilateral MOU with DRC and Zambia for the development of an integrated value chain around LIBs - from extraction of minerals to battery packs
- The MOU is part of the USA's objectives to secure a value chain for its domestic LIB demand
- The MOU positions the USA as a contender to China and to European countries that are courting the DRC and other African countries to secure critical minerals

Strengths	• **Access to critical raw materials -** The DRC produces close to 70% of the world's cobalt, whilst both DRC and Zambia are major producers of copper • Strong **historical cooperation between Zambia and DRC** • **Support from key stakeholders**, including government departments, international agencies, financial institutions and academic institutions
Challenges	• Still at MOU (non-binding) stage with **implementation not yet guaranteed**; Could take long to negotiate finer details, contracts, implementation frameworks, action plans, etc. • **ESG issues in DRC**, particularly with artisanal miners • Ongoing **conflicts and political instability** in DRC • **Weakness in state services** involved in enforcing the Mining Law (governance) • **Lack of robust cross-border infrastructure,** although plans are in place to build key road and rail infrastructure to link to Dar Es Salaam port in Tanzania and the Lobito port in Angola • **Inadequate skills** and technical know-how • Identification of a strong **implementation partner**
Outlook	• Although implementation is not guaranteed, the ambition is to develop this agreement into a **pan-African initiative** with participation from other African countries which possess raw materials essential for battery production. This ambition is **supported by the AfDB**

Source: UNECA, Press articles

DRC/Zambia case study (2/2)

The DRC/Zambia partnership was first established in April 2022 and is currently still in the planning phase, with key infrastructure projects which support the MOU starting to be developed

Timeline

Nov 2021

Release of **Bloomberg's study on the production of battery precursors in the DRC**

The report was commissioned by Afreximbank, UNECA, AfDB, AFC, BADEA and ALSF

Launch of the **Centre of Excellence for Advanced Battery Research** in Lubumbashi, in collaboration with the University of Lubumbashi (UNILU) and Steinbeis Global Institute Germany (SGIT)

Apr 2022

DRC and Zambia sign a **bilateral MOU to develop a cross-border integrated value chain** for the production of EV batteries

Dec 2022

The USA strengthens the existing MOU by signing a **trilateral MOU with DRC and Zambia** for the development of an **integrated value chain around LIBs** - from extraction of minerals to battery packs

Jan 2023

Set up of the **DRC-Zambia Battery Council** to oversee implementation of the MOU

The council includes a committee of experts from **partner institutions** including Afreximbank, AfDB, UNECA, AFC and BADEA

Apr 2023

Afreximbank and UNECA sign an agreement with the DRC and Zambia to **establish special economic zones in both the DRC and Zambia** for the production of LIBs and related services

Sep 2023

Inaugural **DRC-Africa Battery Metals Forum** held in Kinshasa, bringing together various stakeholders with a focus on beneficiation, localisation, ESGs, investor incentives and free trade zones

Oct 2023

Zambia and DRC start the process of building **new bridge and road infrastructure** over the Luapula River as part of a **new road project that will expedite copper/cobalt exports** via the port of Dar es Salaam in Tanzania

EU signs an MOU for a partnership on critical and strategic raw materials value chains with **DRC** and **Zambia**

EU also signs an MOU with USA, DRC, Zambia, Angola, the AFDB and the AFC to support the **development of the Lobito Corridor** – a **transport corridor** to connect the southern part of DRC and the north-western part of Zambia to regional and global trade markets via the Port of Lobito in Angola

Source: UNECA; European Commission; Press articles

South Africa case study (1/3)

Both the government and private sector have indicated their intention to position South Africa in the LIB supply chain. However, despite several initiatives focused on developing the LIB value chain since 2011, there is still no commercial production of LIBs, with only a pilot plant for R&D established

Overview

- As part of South Africa's Energy Storage Research, Development and Innovation Programme, a consortium was established in 2011 to work on developing the LIB value chain, from precursor and material development, to cell and battery manufacturing
- Consortium members include the Department of Science and Innovation, the Council for Scientific and Industrial Research, the University of Western Cape, the University of Limpopo, the University of the Witwatersrand, the Nuclear Energy Council of South Africa, the Nelson Mandela University, and Mintek
- Pilots for LIB plants were established in 2013 and 2017; Pilot processing has taken place and sample batteries produced have been tested at the Nelson Mandela Metropolitan University

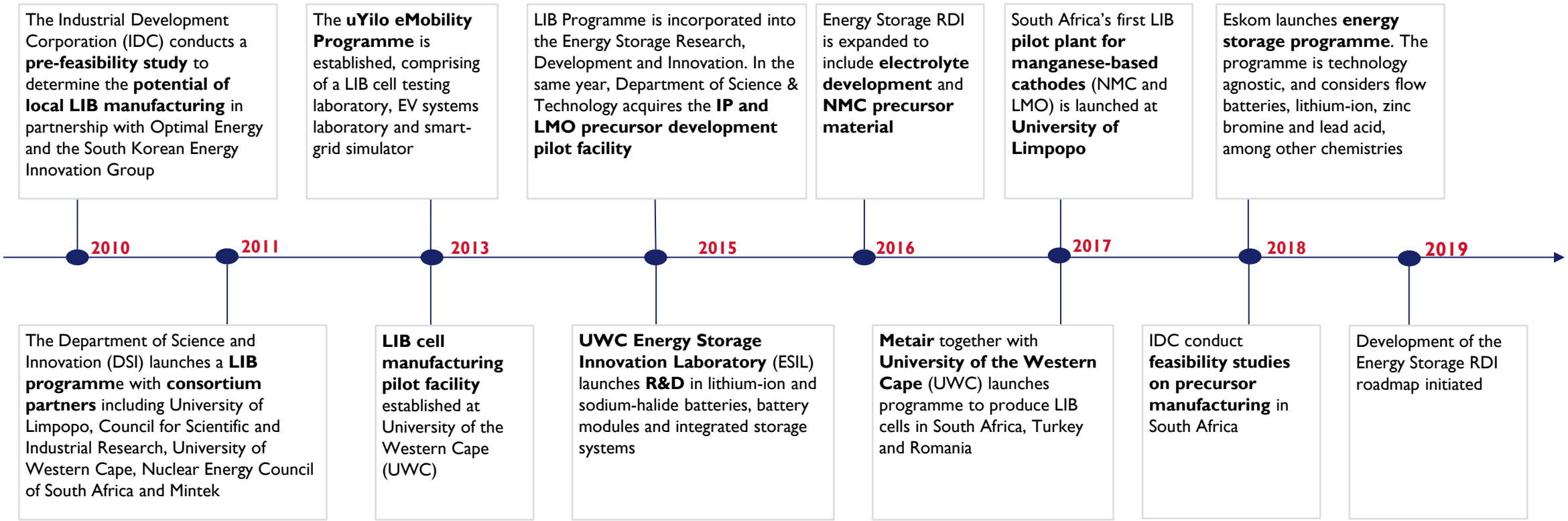
Strengths	• **Mining and beneficiation capabilities:** Availability of critical raw materials locally (manganese, cobalt, iron ore, nickel, titanium), with longstanding experience and expertise in mineral beneficiation • **Investment in R&D and skills development** via the Energy Storage Consortium; Includes training programmes for skilled graduates. Most local entrepreneurs active in the LIB value chain have emerged from academia • **Manufacturing and industrial capabilities:** Lead-acid battery manufacturing based on imported cells from China is already a vibrant industry in the country. South Africa is also the largest automotive manufacturing hub in Africa • **Growing private sector participation,** with several firms developing IP and expertise in the manufacturing of specific components and systems (e.g. battery management systems) and the assembly of battery packs
Challenges	• Despite a focus on the LIB value chain going back to 2011, there is still **no commercial production** of battery cells exists yet (only a pilot plant for R&D) • **Infrastructure issues** hinder South Africa's competitiveness, e.g., delays linked to road infrastructure, ports and customs**; Disruptions in electricity supply** and **rising electricity costs**; and **Water shortages and** increasing vandalism/theft of mainly copper products. These issues have resulted in **closure of some processing activities (smelters)** • **Accessing global markets** has been challenging and highly competitive, requiring niche expertise, e.g. with testing and certification requirements. Additional resources are required to develop skills and IP in specific LIB niches
Outlook	• Both the government and private sector players have indicated their intention to position the local value chain as a key player in LIBs, but successful commercial implementation is yet to be seen

Source: Critical Minerals Africa, Trade & Industrial Policy Strategies (TIPS), World Bank

South Africa case study (2/3)

Despite several initiatives focused on developing the LIB value chain, there is still no commercial production of LIBs. High electricity costs, electricity and water shortages, as well as high levels of crime and governance issues have derailed progress of LIB production in South Africa

Timeline



Source: Trade & Industrial Policy Strategies (TIPS) report: Opportunities to develop the Lithium-ion Battery Value Chain in south Africa, March 2021

South Africa case study (3/3)

Several South African firms are involved in the early stages of various aspects of the LIB value chain, from the development of precursors and materials, as well as activities related to cell manufacturing

AQORA Mining and Manufacturing

- Establishing a **vertically integrated gigafactory** able to produce anodes, cathodes and LIBs for EVs and ESS applications. Production could potentially start in **2026**
- Project will be in the **Eastern Cape** and will leverage several international partners

Megamillion Energizing Africa for its Future www.megamillion.africa

- Working in partnership with Chinese LIB technology experts and **Nelson Mandela University** to develop a US$1.5bn **LIB production facility** in South Africa with a **32 GWh production capacity**
- At conceptual stage as the company is still searching for investors

METAIR INVESTMENTS LIMITED automotive | industrial | retail

- Launched a programme together with the **University of Western Cape** for the production and certification of LIBs
- Established a **pilot LIB production plant** with UWC in 2018
- Metair is already engaged in the manufacturing of LIBs through its **Romanian subsidiary**

Manganese Metal Co

- Largest producer of **manganese** in South Africa; Only supplier of high-grade electrolytic manganese metal (EMM) outside of China
- Beneficiates manganese ore to produce **manganese sulfate, used in LIB cathodes**

THAKADU

- Produces **battery-grade nickel sulfate** from a nickel beneficiation and purification plant at Lonmin's base metals refinery
- Entered into an **agreement with Lonmin** mining company to process Lonmin's crude nickel by-product

Gilgamesh Mineral Processing Company

- Incorporated with IDC funding to develop a manufacturing facility for high purity **battery-grade cobalt sulfate**
- Fundraising has started for project implementation and a strategic equity partner is being sought
- Targeting USA, UK, Germany, Spain, Netherlands, and Turkey as key offtake markets

Source: Company websites, Energy Capital Power, World Bank

China case study (1/2)

The availability of generous government subsidies have been key in developing the battery manufacturing industry in China, with companies such as CATL taking advantage of such government support to build scale and expand globally

China case study

- The Chinese government started **providing subsidies** to promote the growth of the EV sector in 2009. Key government support for the industry included:
  - **Making land available** at very little cost for factories to be built
  - Significant **capex subsidies** to build manufacturing plants
  - **Tax breaks** and subsidies worth up to one third of the cost of an EV, on the condition that OEMs used batteries from a list of approved battery suppliers, including entities such as CATL
- As the industry matured, the Chinese government started to phase out subsidies for EVs from 2020, and established Chinese LIB manufacturers began to look for **expansion opportunities overseas**
- Chinese battery material makers announced plans for **over 20 overseas factories** in 2023, spending **over $14bn**
- Chinese companies are pursuing a deliberate strategy of **vertical integration** along the LIB supply chain and **own various stages of the production process** instead of relying on external suppliers

Key takeaway: Government subsidies are vital in the initial development of the LIB industry given the high capex associated with building the necessary infrastructure

CATL example

- The initial government support provided by the Chinese government provided companies such as CATL with the platform to grow the market
- CATL has since expanded its operations to include key investments in midstream activities. Some examples of their investments include:
  - Investments in production bases and R&D centres in Europe (**Germany and Hungary**)
  - Building a plant processing nickel ore in **Indonesia** which starts production in 2024
  - Acquiring Pilbara Minerals in **South Korea** for the expansion of a Lithium-Tantalum processing facility to produce lithium hydroxide
  - Purchasing stakes in mining projects in the South American lithium triangle (**Argentina, Bolivia and Chile**)
  - Investment in cobalt mines in the **DRC**

Source: S&P Global, Press articles

China case study (2/2)

China's recent restrictions on the exports of graphite and production processing technologies are signals that the country is consolidating its dominance and control of the supply chains needed for LIBs and EVs. The entry of Xiaomi into EVs is a further sign of China's global consolidation in the sector

China's restrictions on essential exports

- In Oct 2023 China issued a **restriction on the export of battery-grade graphite**, which is used in the anodes of LIBs
- In Dec 2023, China announced a **ban on the export of technology used for the mining, ore-dressing and smelting of Rare Earth Elements.** The ban includes technology for separating rare earths as well producing metal and magnets
- China is the world's dominant producer of rare earth metals, and is also the dominant supplier of graphite globally, accounting for over 70% of global supply
- The EU relies on China for over 60% of its supply of critical raw materials for LIBs such as cobalt ore, manganese and graphite. **The EU is therefore implementing a strategy to reduce dependency on China,** diversify the supply chain, and strengthen relations with other mineral-producing countries

Key takeaway: China's export ban on processing technologies could expedite innovation and investment in new technologies as well as new processing facilities outside of China

Xiaomi's EV entry

- Xiaomi's recent move into EVs signifies a **strategic shift** by the smartphone company which is now aiming to become a **strong contender in automotive technology**
- Xiaomi has pledged to **invest $10 billion in EVs** over the next decade as it seeks to diversify beyond its core business to EVs amid stagnating demand for smartphones
- Xiaomi has **partnered with state-owned Beijing Automotive Group** (BAIC) which already produces EVs for the domestic market
- Xiaomi's EVs will come with a choice of two battery packs:
  - **LFP battery** sourced from **BYD** for the entry level EV
  - **NMC** cell-to-body battery supplied by **CATL** for the higher-end EV models.
- Xiaomi has **built its own battery pack production plant**; Its NMC cell-to-body battery was jointly developed by Xiaomi and CATL over the last two years

Source: Press articles

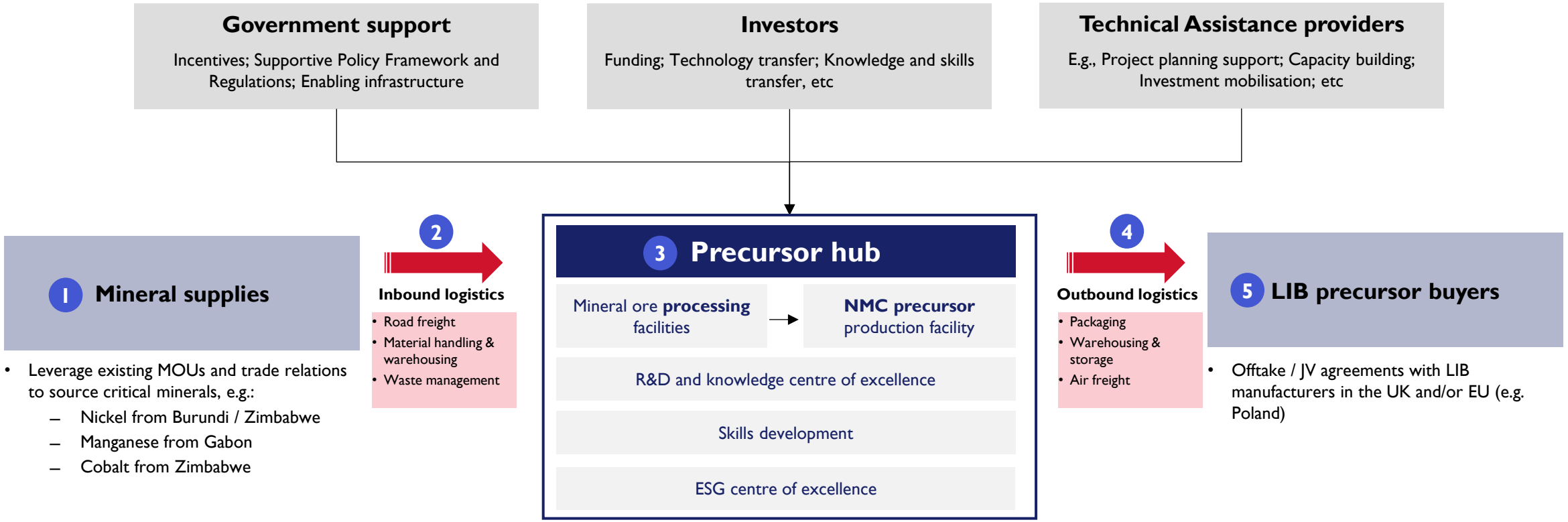
SECTION 4.2

Rwanda's competitive positioning

Rwanda as a potential provider of NMC precursors into the UK and EU markets

Rwanda has potential to become an LIB precursor processing hub in East Africa by positioning itself in the centre of a regional value chain and taking advantage of growing demand in the UK and EU for nearshoring solutions in the LIB supply chain

Potential precursor manufacturing model in Rwanda



Source: Proprietary analysis, Subject Matter Experts

Mineral supplies – Access to critical raw materials in the region

Rwanda has standing MOUs with several countries in the region for the supply of key minerals for value-addition and processing, and is well-positioned to set up additional MOUs with selected countries to secure the supply of critical LIB raw materials

Opportunities for regional collaboration

- Rwanda has **standing MOUs** with several countries in the region for the **importation of key minerals** for its gold refinery plant and its tin smelting plant
- The MOUs serve to **supplement Rwanda** with the necessary minerals to grow its mineral processing sector and become a **regional mineral value-addition processing hub**
- Rwanda has an opportunity to set up **additional MOUs** with selected countries in the region to secure the supply of critical LIB minerals, e.g. with **Burundi** (for Nickel), **Gabon** (for Manganese) and **Zimbabwe** (for Cobalt)
- Rwanda has established strong **trade and economic cooperation with Zimbabwe**, including on mining and mineral beneficiation
- Rwanda also has **strong historical trade relations with Gabon;** In Jan 2024, a delegation of Rwandan investors and government officials visited Gabon to strengthen trade ties and explore new opportunities for collaboration

Zoom on Rwanda's strong trade and economic cooperation with Zimbabwe

Date	Remarks
Aug 2019	• Rwanda and Zimbabwe sign an MOU on **cooperation and exchange of information on the mining and extractive industries** • The MoU includes cooperation in areas of **sharing training facilities in the mining sector**, as well as enhancing production of minerals
Dec 2021	• Rwanda and Zimbabwe sign MOU on the exchange of educational personnel and expertise as part of Rwanda's **Human Capital development**
Sep 2021	• Inaugural Zimbabwe-Rwanda Trade and Investment Conference takes place in Kigali to explore areas of collaboration and partnerships • **Rwanda and Zimbabwe sign five MOUs** in agriculture and livestock, environment and climate change, tourism and business events, ICT and e-Government
Mar 2022	• The second Zimbabwe-Rwanda Trade and Investment Conference takes place in Harare • **Rwanda and Zimbabwe sign three MOUs** in energy, commercial and economic relations, and trade & investment
May 2023	• **Rwanda and Zimbabwe sign three additional MOUs** in cooperation in Higher & Tertiary Education, Science & Technology, and Housing development

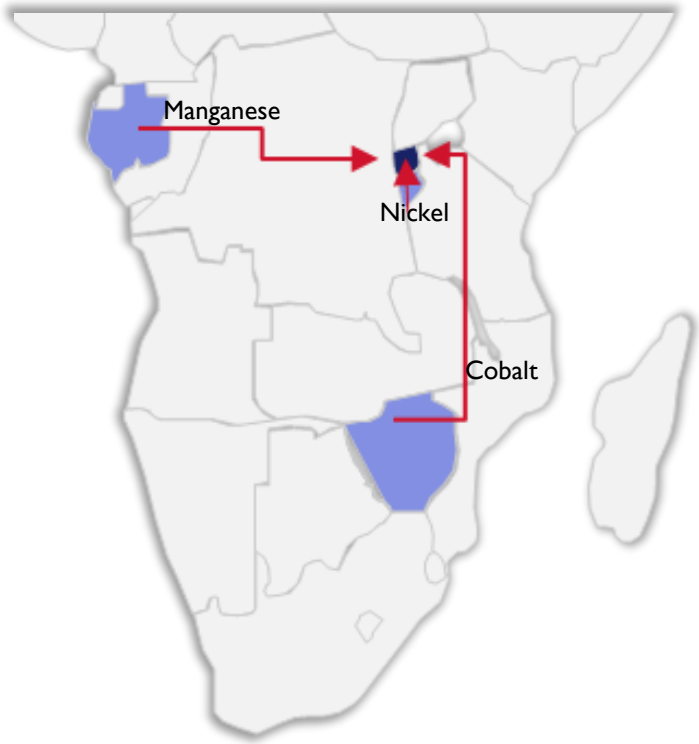
Source: Subject Matter Experts, Press articles

Inbound logistics

There are high risks and complexities associated with cross-border road-freight in Africa, such as poor roads, security issues and customs delays at country borders. These risks, plus the long distance, are significant additions to the cost of inbound transportation

Illustrative inbound logistics routes

Mineral	Source country	Freight method	Comments
Nickel	Burundi	Road freight	• Road freight route • **~3 days** total transit time
Manganese	Gabon	Road freight	• Road freight route via Republic of Congo and DRC • **~7 days** total transit time
Cobalt	Zimbabwe	Road freight	• Road freight route • **~7 days** total transit time

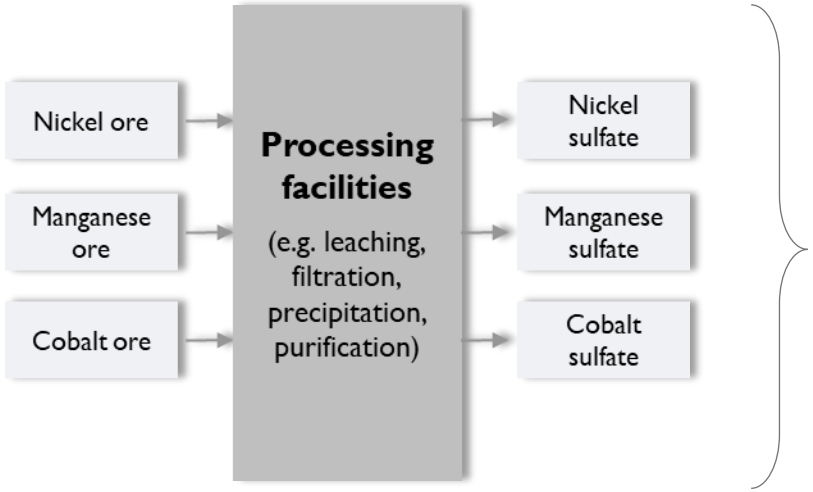


Source: Proprietary analysis, Subject Matter Experts

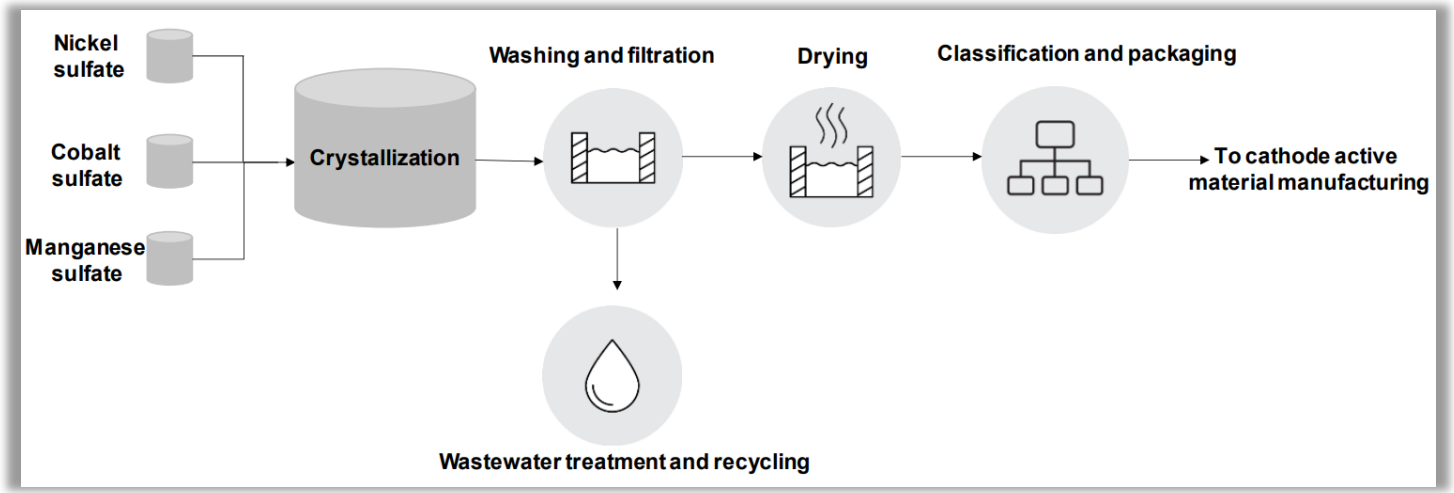
Precursor hub

Critical minerals can be imported in raw form, with further processing to battery-grade sulfates taking place in Rwanda

Mineral ore processing facilities



Illustrative NMC precursor manufacturing process



Source: BloombergNEF

Key enablers

- R&D and knowledge centre of excellence
- Skills development
- ESG centre of excellence

Source: Subject Matter Experts, BloombergNEF

Outbound logistics

As finished precursor materials are high value goods, they will be transported via air freight into European / UK markets

Air freight as the preferred outbound transportation mode

- Rwanda's national airline **RwandAir** has experience in handling air freight of high value goods such as gold, platinum, and other mining minerals to markets in Europe, Asia and the Middle East
- RwandAir has relevant security systems and regulatory procedures in place and **is well placed to handle shipments of precursor materials**
- **RwandAir and Qatar Airways** also jointly operate the **Kigali Cargo Hub** with a dedicated Boeing 737-800 converted freighter included in the freight fleet
- In addition, international airlines such as **Brussels Airlines**, **KLM** and **Turkish Airlines** operate several direct flights from Kigali into Europe weekly, and have capacity to carry high value cargo

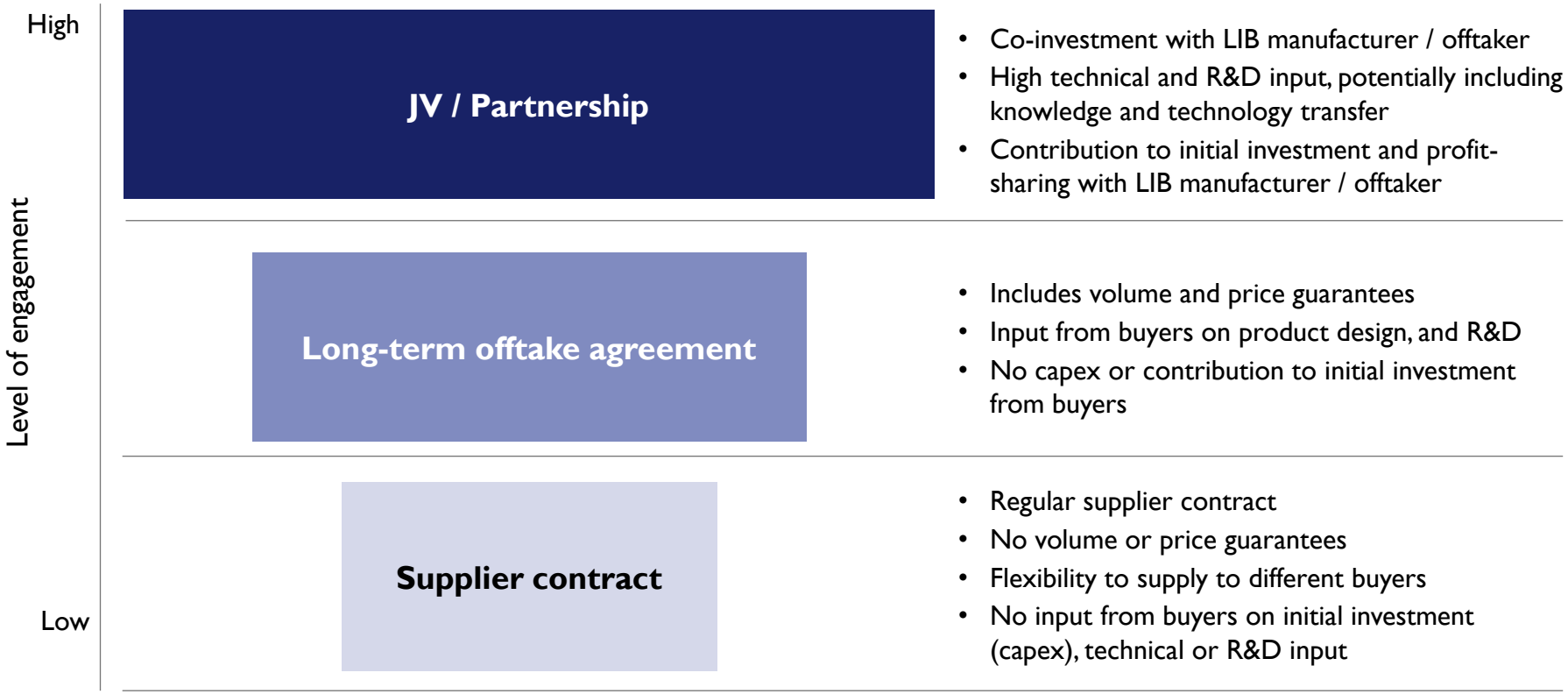
Airline	Direct routes
RwandAir (Fly the dream of Africa)	Brussels (3x a week) London (6x a week)
brussels AIRLINES	Brussels (6x a week)
KLM Royal Dutch Airlines	Amsterdam (5x a week)
TURKISH AIRLINES	Istanbul (7x a week)
QATAR AIRWAYS القطرية	Doha (2x a week)

Source: Proprietary analysis, Subject Matter Experts

LIB precursor offtakers

A JV/Partnership with an offtaker is the highest level of engagement and most ideal as it offers Rwanda the greatest potential for success via secured funding, knowledge and skills transfer. This solution also provides an LIB manufacturer with the strongest level of risk mitigation for their supply chain

Potential levels of engagement with LIB manufacturers



Examples of potential NMC offtakers in Poland

LG Energy Solution Wrocław Sp. z o.o.

umicore

ionway BATTERY MATERIALS FOR THE EV TRANSITION

Source: Proprietary analysis, Subject Matter Experts

Key success factors for Rwanda to penetrate the LIB value chain

Key success factors for Rwanda to penetrate the global LIB supply chain include securing long-term offtake agreements with relevant partners; Accessing critical raw materials for the processing of precursor materials; and Developing technical and operational competence to effectively execute the project

Key success factors

Demand dynamics	**Secure long-term offtake agreements** • Ability to secure long-term offtake agreements with buyers in the EU / UK / USA • Build synergies with battery manufacturers through the establishment of JVs or equity partnerships that ensure a secure value chain
Supply dynamics	**Access to critical raw materials** • Ability to establish and manage a consistent, transparent and ethical supply-chain of critical raw materials from other countries • Successfully navigate any international trade bureaucracies to ensure adequate supplies • Incentivize the importation of raw materials for local processors, e.g. through revision of the mineral tax
Competitive dynamics	**Develop technical competence** • Excel in technical execution, manufacturing efficiency, R&D and cost competitiveness • Adhere to international standards and regulations • Establish regional alliances which foster collaboration in a multi-stakeholder environment

Source: Proprietary analysis, Subject Matter Experts

Why Rwanda?

Fast growing

- **6th** fastest growing economy in Africa (7.5% p.a. since 2007)
- **Most improved** nation in human development in the world
- Young and growing population (**~70%** of population under 30)

Low risk

- **5th safest** country to walk at night worldwide
- **Lowest debt ratio** in region & stable credit ratings
- **Stable** currency

Business friendly & modern

- **2nd** for doing business in Africa[1]
- **1st** for Government transparency in Africa
- **Most women** in Parliament and in a gender-balanced Cabinet in the world (respectively 61% and 52%)

A regional platform

- Strong **African hub** potential; highly **connected** African airline
- **2nd** MICE City ranking in Africa; +5 ranks in 5 years
- Growing **bilingual,** educated workforce (23k tertiary and 42K TVET grad./yr)

IT ready

- **1st** in the EAC for network readiness
- **5th** in Africa
- **95%** 4G LTE network coverage; 7,000km fibre

Source: Rwanda Development Board (RDB), Doing Business 2020, UN (UN-HDI), World Bank, WEF, Global and Africa Competitiveness Report, ICCA, Global Gender Gap report, Gallup, ICCA, RDB, BSC, GoR, Statistical year book

Rwanda's competitive advantages (1/5) – Strength of infrastructure

Rwanda has robust infrastructure with a good road network, secure border, and reliable power & water availability. Although the country is landlocked there is good access to regional ports in Mombasa and Dar-Es-Salaam as well as several regional and international airlines flying directly into Kigali

Strength of infrastructure

Road network	• **Good road network** connecting provinces and district across the country • Further investment in the road network, particularly in remote areas, is a key part of Rwanda's economic development strategy
Secure borders	• Good **track record of security**, safety and strong border control for mineral importers and exporters • Ease of access with citizens of all countries allowed to get **visa upon arrival** without prior application
Access to regional ports	• Access to regional ports such as **Mombasa** in Kenya and **Dar-Es-Salaam** in Tanzania for shipping logistics • Development of the **Tanzania Standard Gauge Railway** is underway (an electrified railway which connects Dar es Salaam to Kigali)
Air transportation	• Globally connected via **RwandAir** - 6x weekly flights to London with at least 14T freight capacity • Availability of several **regional and international airlines** serving Kigali
Utilities	• **Reliable power** availability & capacity, with no power shortages • **Water is widely available** throughout Rwanda
ICT infrastructure	• **High internet access** - 1st in EAC for network readiness, 5th in Africa ; 95% 4G LTE network coverage, 7,000 km fibre • **Digitized mining geological information** available on the Geological Information and Mining Cadaster System (GIMCS)
Financial services	• Access to international capital via the **Kigali International Financial Centre (KIFC)**
Special Economic Zones	• Access to Special Economic Zones for businesses, with **fully serviced industrial and commercial land**, reduced energy tariffs, quality infrastructure and competitive fiscal and non-fiscal regulations

Source: Rwanda Development Board (RDB), Rwanda Mines, Petroleum and Gas Board (RMB)

Rwanda's competitive advantages (2/5) – Enabling business environment

Rwanda has put in place several incentive mechanisms which engender a strong enabling business environment and support investments in the country. These include business friendly regulations, multiple tax incentives, efficient investor processes and a commitment to foreign ownership

Business friendly regulations

- Ranked #2 in Africa for Ease of Doing Business and Global Competitiveness
- Ranked #4 least corrupt country in Africa
- Total effective tax is lowest in the East African Community (EAC) region

Multiple incentives, largely for exporters

- Preferential corporate income tax rate (15% if 50% is exported)
- Accelerated first year depreciation rate of 50% for key priority sectors
- Exemption of capital gains tax and 0% tax if HQ is in Rwanda
- Seven-year corporate income tax holiday for large projects in strategic sectors
- Duty-free imports of machinery and inputs

Efficient, supported processes

- Highly digitalized and efficient administration
- Free business registration
- One-stop center for investor with dedicated investment acceleration team

Commitment to foreign ownership

- No restrictions to foreign ownership
- No restrictions on capital flows
- No foreign exchange controls – currency freely convertible

Source: Rwanda Development Board (RDB)

Rwanda's competitive advantages (3/5) – Skills development

The government of Rwanda is proactively working to mitigate the skilled workforce shortages through several strategies including engagement of expatriates and Rwandan diasporans, as well as partnering with selected countries on specific skills development programmes

Overview

- The Rwandan government recognises the **shortage of technical skills** and advanced knowledge in mining and mineral processing in the country
- Through its Chief Skills Office, the government is proactively working to mitigate the skilled workforce shortage through several strategies including **engagement of expatriates** and **Rwandan diasporans**, as well as partnering with selected countries on specific **skills development programmes**
- The goal is for Rwanda to grow both its **academic and vocational capabilities** in mineral processing

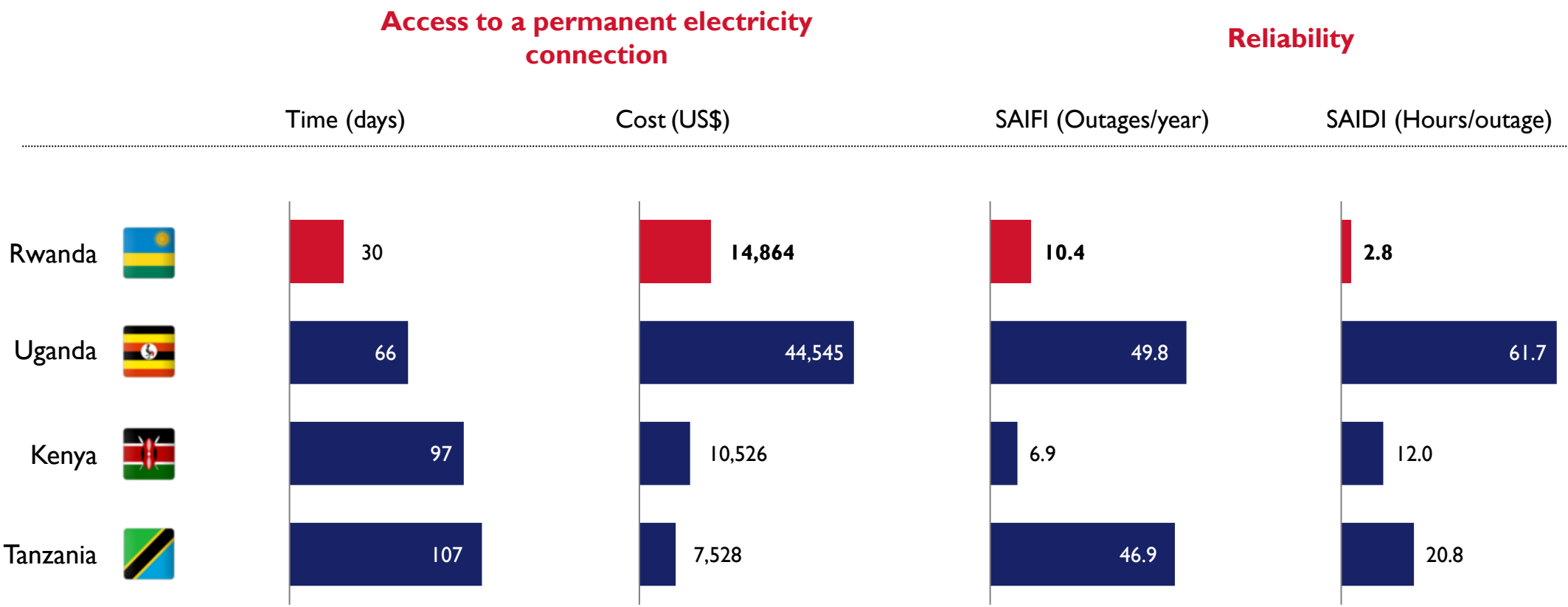
Current strategies to attract, train and retain a skilled workforce

Attract talent	• Engagement of **expatriate knowledge** and **recruitment of talent from neighbouring countries**, including having proactive **skills transfer programmes** in place • RDB's Skills Office brings international expats into targeted sectors such as mining through its **Strategic Capacity Building Initiative.** There are currently expats who are working within RMB to provide coaching on mining extracting and value addition technologies • Active engagement with the **Rwandan diaspora in Europe and North America** through programmes such as the Rwandan Diaspora Skills Transfer Project run by the International Organization for Migration (IOM)
Train & retain talent	• The University of Rwanda's **School of Mining and Geology** as well as **polytechnical colleges** such as IPRC Kigali play a pivotal role in training and building capacity of young leaders in the mining industry through **academic and technical qualifications** in Mining Engineering and Applied Geology • Rwanda has partnered with **Curtin University of Australia** under a 5-year MOU on mining extraction and value-addition **knowledge exchange and skills transfer programmes**. This includes the setting up of a mining technical skills centre of excellence in Kigali and a mining demo site which will be used for training purposes • Rwanda has **bilateral cooperation agreements** with several countries on skills development. For example, selected Rwandan professionals gain **scholarships** every year to study specific academic and professional courses from partner organisations in **China, Japan and Korea**

Source: Rwanda Development Board (RDB), Subject Matter Experts

Rwanda's competitive advantages (4/5) – Rapid access to electricity & high reliability

Investors in Rwanda benefit from rapid access to electricity and high reliability compared to other countries in the region. The time to obtain a permanent electricity connection in Rwanda is ~30 days compared to over 60 days in neighbouring countries



SAIFI = System Average Interruption Frequency Index; SAIDI = System Average Interruption Duration Index.

Source: Rwanda Development Board (RDB), Doing Business 2020

Rwanda's competitive advantages (5/5) – Capabilities in the EV sector

There are several initiatives underway in Rwanda's EV sector, including announced government targets and tax incentives. The sector is already attracting a growing ecosystem of EV startups as well as a focus from international automotive OEMs such as Volkswagen and Mitsubishi

Current initiatives in the EV sector in Rwanda

Government targets	• By 2030, Rwanda aims to have **20% of buses, 30% of motorcycles and 8% of cars electrified** • EVs are expected to account for 60-75% of all two-wheeler sales by 2040
Government incentives	• EVs, including their spare parts, batteries and charging station equipment, are **exempt from VAT, import and excise duties** • **Subsidised electricity tariffs** are offered at EV charging stations • Reliable availability of electricity throughout Rwanda • Land for charging stations is offered **rent-free** by the government
Growing ecosystem of EV start-ups	• **Ampersand** - Assembles and finances e-motorcycles, and offers battery swapping (BaaS) services • **Kabisa** - E-mobility company; Sells and leases EVs; Operates a network of charging stations • **SafiRide** - An on-demand E-Mobility rideshare company based in Kigali, Rubavu and Musanze • **Rwanda Electric Motorcycle Company (REM)** - E-motorcycle company; Offers dual batteries
Presence of international OEMs	• **Volkswagen (VW)** assembles its e-Golf EV model in Rwanda; VW is also looking to introduce locally assembled electric tractors for Rwandan farmers • Victoria Motors Rwanda assembles and promotes **Mitsubishi's** Outlander PHEVs and e-buses in Rwanda

Ampersand example

AMPERSAND

- Ampersand is an EV transport energy company which provides **commercial e-motorcycles and battery swapping services**
- It employs a battery-as-a-service **(BaaS**) model, selling its EV 2-wheelers without the battery but offering the battery on a rental basis
- Has developed a network **of battery-swapping stations** to enable 2-wheeler drivers to exchange depleted batteries for fully charged batteries on the go
- Has a fleet of ~1,000 cars, with a target to increase this to **over 10,000 by 2025**
- Backed by **several investors** including DFC, Ecosystem Integrity Fund (EIF), Acumen, Hard Edged Hope Fund and Africa Go Green Fund

Source: McKinsey, United Nations Environment Programme (UNEP), Press articles, Company websites

Appendix

Top global investors in LIB value chains (2016-2022)

OEMs

Investor	HQ country
Tesla	US
BMW	Germany
Hyundai	South Korea
Volkswagen	Germany
Toyota	Japan
Stellantis	Netherlands
Mercedes Benz	Germany
Vinegroup	Vietnam
Ford	US
Bravo	US
Honda	Japan
Groupe PSA	France
GM	US

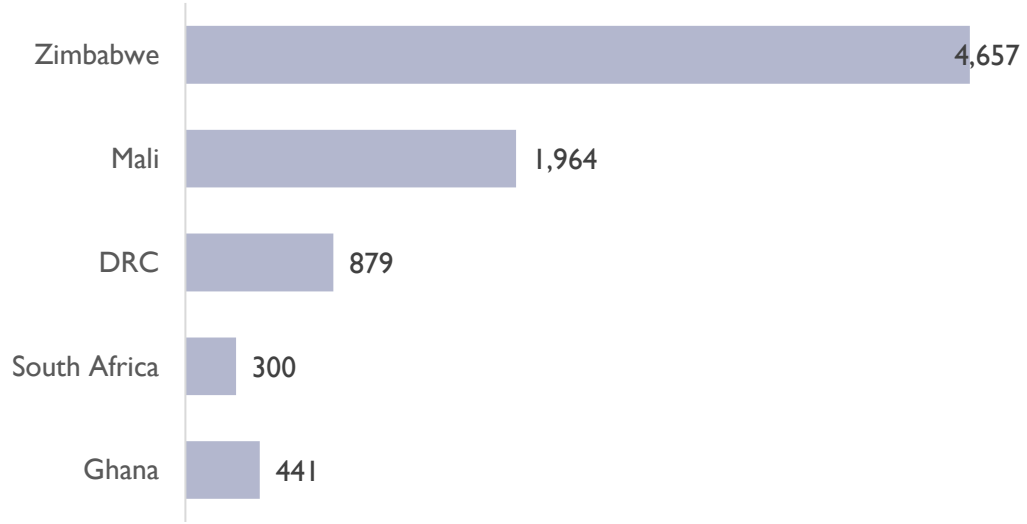
Battery makers

Investor	HQ country
CATL	China
LG	South Korea
SK Group	South Korea
Foxconn	Taiwan
Envision Energy	China
Northvolt	Sweden
Panasonic	Japan

Source: FDI Intelligence

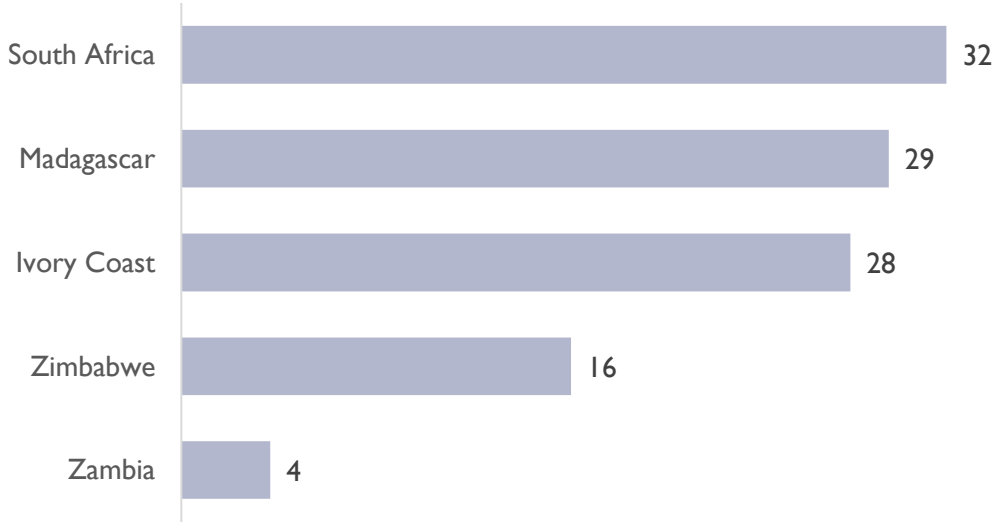
Top producers of key LIB minerals in Africa (1/2)

Lithium production capacity in Africa
2021, in thousands of metric tons



- Zimbabwe has the largest lithium reserves in Africa; It produces Spodumene lithium which is of higher purity and has a short lead time to production and processing than Brine

Nickel production volume in Africa
2021, in thousands of metric tons

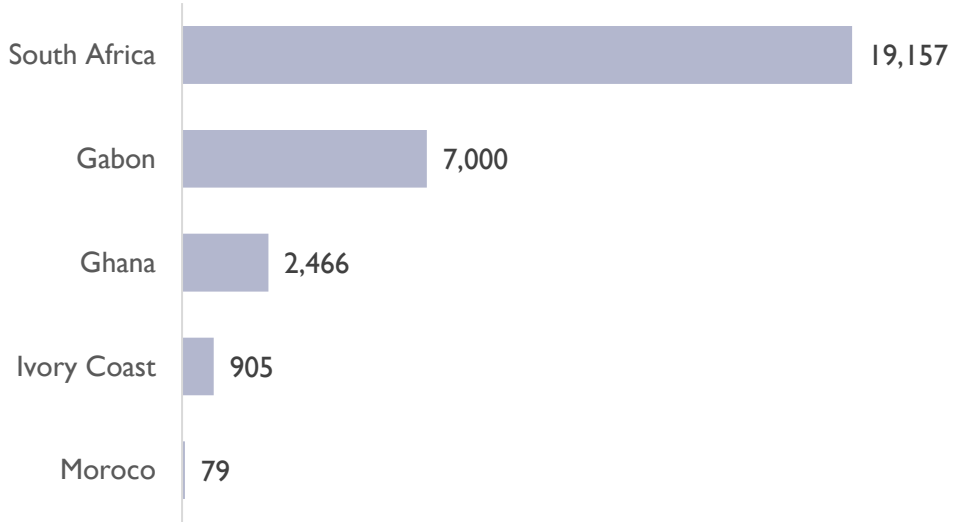


- In South Africa and Zimbabwe, nickel is produced as by-products of platinum group metals (PGM)

Source: Statista, International Lithium Association,

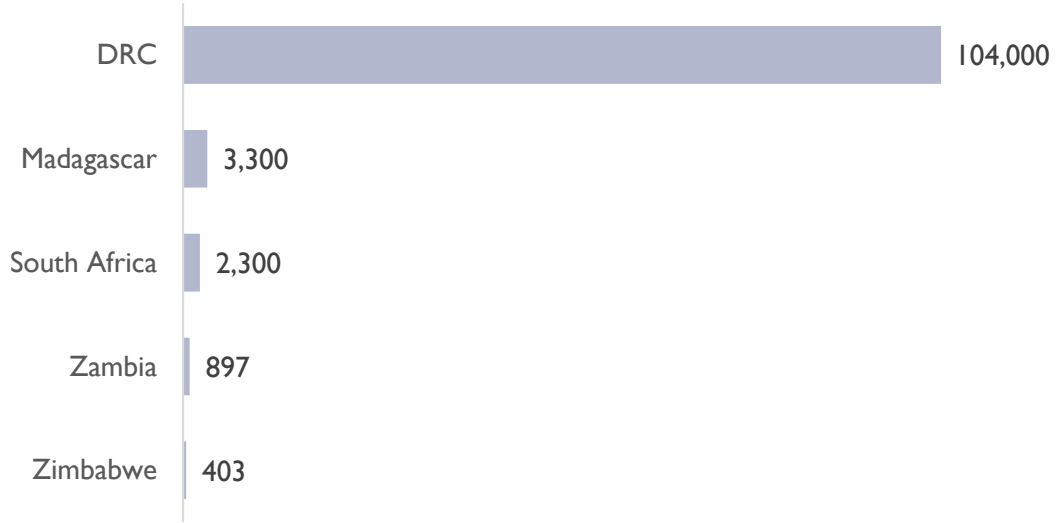
Top producers of key LIB minerals in Africa (2/2)

Manganese production volume in Africa
2021, in thousands of metric tons



- Manganese is generally an abundant mineral and is often found with iron ore deposits

Cobalt production volume in Africa
2018, in metric tons



- Cobalt is predominantly produced as a by-product from either copper or nickel mines
- The DRC has the largest cobalt mineral reserves in the world, equivalent to ~51% of global cobalt reserves

Source: Statista

Additional examples of countries in Africa penetrating the LIB value chain

	Overview	Key strengths
Morocco 	• Positioning to become MENA's regional hub for EV manufacturing • In June 2023 the Moroccan government signed an MOU with **Chinese LIB manufacturer Gotion High-Tech** for the construction of Africa's first LIB gigafactory. The deal is estimated to be worth ~ $6.4bn • In Sep 2023 **China's CNGR Advanced Material announced plans to build a $2bn cathode materials plant in Morocco**, intended to supply the US and European battery markets • Morocco is reported to be working with three major international OEMs to **build EV manufacturing plants** and aims to build production capacity of 1 million EVs by 2025	• Availability of critical raw materials locally (Cobalt, phosphate) • Close proximity to Europe • Already has a well-developed auto parts and components manufacturing sector with well-developed existing industrial facilities • Two European OEMs (Renault and Stellantis/Opel) already have operations in Morocco • Moroccan mining company Managem offers local supplies of EV batteries to BMW and Renault
Zimbabwe 	• Has the largest deposits of high-grade lithium in Africa • Export controls for lithium introduced in 2022 to stop exports of raw (unprocessed lithium) and **encourage local processing** • This has attracted mainly Chinese investors into Zimbabwe who are looking to build production facilities near the mines. Examples include: – **Chinese battery minerals producer Zhejiang Huayou Cobalt** - started trial production of lithium concentrates at its Arcadia mine in Zimbabwe – **China Natural Resource** announced a $1.75 billion deal to acquire Williams Minerals, the rightsholder of a lithium mine in Manicaland Province	• Availability of critical raw materials locally (lithium, cobalt, nickel, graphite, iron)

Source: AfDB, press articles

To discuss this opportunity further please contact:

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