

DISCUSSION PAPER No. 359

## **Green industrialisation: Leveraging critical raw materials for an African battery value chain**

**By Poorva Karkare and Alfonso Medinilla**

November 2023

African countries are exploring opportunities to add more value to their critical raw materials for green industrialisation. This paper assesses the potential for an African lithium-ion battery value chain as a case.

It argues that while green industrialisation ambitions hold promising new prospects for African economies, they nonetheless add another layer of complexity to already existing challenges. The interplay of actors and interests at different levels collectively influences these 'green windows of opportunity'.

Presently, African countries mainly supply raw materials in the global battery value chain, while China leads in both manufacturing and innovation. The US and the EU strive to catch up, but it is unclear how their geostrategic goals support African industrialisation.

African processing and manufacturing for batteries will depend on establishing a regional value chain, supported by the African Continental Free Trade Area. But this requires overcoming the structural, institutional and coordination challenges that have limited regional industrialisation in the past. At the same time, there is a need for effective implementation of policies at the national level. This involves using limited resources to build domestic capabilities through robust industrial policies while balancing diverse interests and incentives.

To capitalise on opportunities at different stages of the value chain, African countries should (i) improve mining potential for socio-economic development, (ii) implement targeted industrial policy to develop capabilities in the battery value chain, (iii) ensure market access to maximise export potential, (iv) proactively position themselves amid geopolitical competition between great powers, and (v) involve private sector actors early in the process.

---

## Table of Contents

|                                                                           |     |
|---------------------------------------------------------------------------|-----|
| Acknowledgements .....                                                    | iii |
| Acronyms .....                                                            | iii |
| 1.Introduction .....                                                      | 1   |
| 2.Sector characteristics: unpacking the battery value chain .....         | 3   |
| Current capabilities in Africa .....                                      | 3   |
| Evolving battery technologies and chemistries .....                       | 5   |
| 3.Geopolitical factors: Chinese dominance and EU and US aspirations ..... | 6   |
| Implications for African economies .....                                  | 9   |
| 4.Regional factors: structural barriers for African participation .....   | 10  |
| Infrastructure and connectivity .....                                     | 11  |
| Link between the <i>regional</i> and <i>global</i> value chain .....      | 11  |
| Between cooperation and competition .....                                 | 11  |
| 5.National factors: industrial policy and linkages .....                  | 12  |
| Jobs, productivity and skills.....                                        | 12  |
| Balancing the competing objectives of industrial policy .....             | 13  |
| Experiments with resource nationalism .....                               | 14  |
| 6.African opportunities in the battery value chain .....                  | 16  |
| 7.Recommendations.....                                                    | 18  |
| References.....                                                           | 21  |

## List of Boxes

|                                              |    |
|----------------------------------------------|----|
| Box 1: Lessons from Morocco .....            | 14 |
| Box 2: Resource nationalism in the DRC ..... | 15 |

## List of Figures

|                                                                        |    |
|------------------------------------------------------------------------|----|
| Figure 1: African share in selected minerals, % of global (2020) ..... | 1  |
| Figure 2: From mine to EVs - the battery value chain .....             | 3  |
| Figure 3: China's position in the global battery value chain .....     | 7  |
| Figure 4: Opportunities for an African battery value chain .....       | 16 |

## List of Tables

|                                                         |   |
|---------------------------------------------------------|---|
| Table 1: Battery and cell components manufacturing..... | 4 |
|---------------------------------------------------------|---|

---

## Acknowledgements

The authors thank Vincent Obisie-Orlu for his inputs during the research phase of this project, and Dr. Bruce Byiers for his constructive feedback on earlier drafts of this paper. They also acknowledge the several experts who made time to share their critical insights for the research as well as provided feedback on the paper. Thanks also to Robin Van Hontem and Studio Kernland for the graphic design and Carlotta Maria Paschetto for layout.

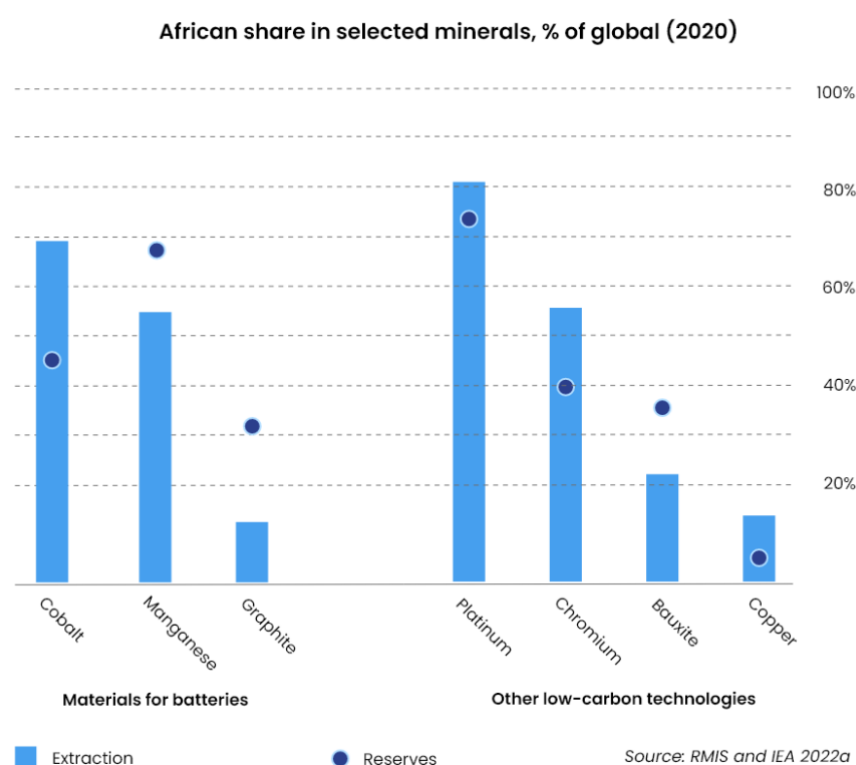
## Acronyms

|        |                                                    |
|--------|----------------------------------------------------|
| ACF    | African Climate Foundation                         |
| AfCFTA | African Continental Free Trade Area                |
| AfDB   | African Development Bank (Group)                   |
| AGOA   | African Growth Opportunity Act                     |
| ANRC   | African Natural Resources Centre                   |
| ATI    | African Transformation Index                       |
| BNEF   | BloombergNEF                                       |
| BYD    | Build Your Dreams                                  |
| CATL   | Contemporary Amperex Technology Co.                |
| CoEU   | Council of the European Union                      |
| CRMA   | Critical Raw Materials Act                         |
| CRMs   | Critical Raw Materials                             |
| DRC    | Democratic Republic of the Congo                   |
| EIU    | Economist Intelligence Unit                        |
| ESG    | Environmental, Social and Governance               |
| ETC    | European Transport Conference                      |
| EU     | European Union                                     |
| EVs    | Electric Vehicles                                  |
| FTA    | Free Trade Agreement                               |
| GHG    | Green House Gas                                    |
| GVCs   | Global Value Chains                                |
| IEA    | International Energy Agency                        |
| IRA    | Inflation Reduction Act                            |
| IRENA  | International Renewable Energy Agency              |
| LCO    | Lithium Cobalt Oxide                               |
| LFP    | Lithium Iron Phosphate                             |
| LIB    | Lithium-ion Battery                                |
| LMO    | Lithium Manganese Oxide                            |
| MoU    | Memorandum of Understanding                        |
| MSP    | Mineral Security Partnership                       |
| NCA    | Lithium Nickel Cobalt Aluminium Oxide              |
| NMC    | Manganese Cobalt Oxide                             |
| OEMs   | Original Equipment Manufacturers                   |
| R&D    | Research and Development                           |
| RMIS   | Resource Management Information System             |
| RVC    | Regional Value Chain                               |
| SEZ    | Special Economic Zones                             |
| UNCTAD | United Nations Conference on Trade and Development |
| UNECA  | United Nations Economic Commission for Africa      |
| US     | United States                                      |

## 1. Introduction

As global momentum builds for a green transition, there is growing recognition that Africa will play a vital role. The continent possesses substantial reserves of so-called critical raw materials (CRMs), and approximately a fifth of those needed for battery-powered vehicles (Diene et al. 2022; UNCTAD 2023; de Féligonde and Benoît 2023).<sup>1</sup> Figure 1 illustrates Africa's contribution to the extraction of these minerals as well as its reserves ([see interactive map for countries with battery minerals and processing activities](#)).

**Figure 1: African share in selected minerals, % of global (2020)**



Many African governments have stated their ambitions to add more value to their resources through processing. This aligns with the goal of economic diversification to break away from the past economic model of merely supplying raw materials in global value chains (GVCs), and is an explicit goal of the African Continental Free Trade Area (AfCFTA), that also seeks to promote regional value chains (RVCs). In that vein, the development of a regional lithium-ion battery (LIB) value chain, where CRMs are as essential inputs, is a key priority to maximise the 'Made in Africa revolution' (AfCFTA and UNDP 2022).

At the same time, GVCs, especially of green technologies, are increasingly subject to geopolitical tensions, as the world's major economies seek to secure access to CRMs for their green transition and to strengthen their position as big manufacturers of these technologies (Maihold 2022). In this evolving landscape, African countries may have opportunities to enhance their bargaining power vis-à-vis external partners by leveraging their resources to build further economic linkages and collaborating at the regional level (Müller 2023).

<sup>1</sup> While there is a lack of consensus on which minerals are CRMs (Cloete et al. 2023), they are minerals that the EU and the US "deem critical to their national security and economic development that are prone to supply chain disruption" (Mavhunga 2023).

---

The United States of America (US) and the European Union (EU) have both signed separate Memoranda of Understanding with the Democratic Republic of Congo (DRC) and Zambia, to enhance CRM extraction and processing, and centralise battery production in Africa (US Dept. of State 2022; EC 2023). The US and EU, looking to secure access to African resources in turn, have also committed to the expansion and refurbishment of the Lobito Corridor connecting Eastern DRC to the Atlantic port of Lobito in Angola (White House 2023a).

The African Export-Import Bank (Afreximbank) and the United Nations Economic Commission for Africa (UNECA) have also signed a framework agreement with the DRC and Zambia (Afreximbank 2023), reinforcing their bilateral agreement to establish two special economic zones (SEZs) in Katanga (DRC) and Copperbelt (Zambia) respectively (ANRC 2022) for which a pre-feasibility study is underway.<sup>2</sup> Plans include building a 10,000 metric tonnes precursor facility in the DRC, deemed more cost-effective and environmentally friendly than production in the US, China, or Poland, given proximity to raw materials and a relatively clean electricity grid (BNEF 2021).<sup>3</sup>

Additionally, Zambia secured a Chinese firm's investment commitment to establish a LIB manufacturing plant in its Southern Province (Chen 2023). LIB gigafactories are also planned in Morocco and South Africa, to supply LIB cells for renewable energy storage and electric cars for both intra-Africa and international exports (Pilling 2023; Whitehouse 2023).

These initiatives show that African countries could indeed play a vital role in producing key green technologies. Yet, achieving this goal, and developing high-tech production facilities across Africa will require an alignment of political and economic incentives from the geopolitical to the regional, national, and sectoral level. This paper maps the various actors and factors influencing these opportunities, examining their impact in practice.

The paper argues that while green industrialisation ambitions hold promising new prospects for African economies, they nonetheless add another layer of complexity to existing industrialisation challenges as the interplay of actors and interests at different levels collectively influence these 'green windows of opportunity' (Lema et al. 2021). By laying out these factors, this mapping paper provides a useful lens for understanding the potential for green industrialisation in Africa in practice.

### Analysing green industrialisation opportunities

This paper follows the approach by Byiers and Medinilla (2023 forthcoming) on conceptualising green industrialisation opportunities in Africa along a continuum of

1. decarbonising existing industries through imported technologies,
2. producing inputs for green global industries,
3. producing/assembling green manufactured (finished) goods,
4. green innovation to greater value addition

Each of these strategies will be affected by a range of structural and institutional factors, and actors operating at different levels, from the geopolitical, to continental, regional, national and local.<sup>4</sup> Successful industrial development in Africa will be affected by and need to work around these multi-level factors.

---

<sup>2</sup> An operating company in consortium with public and private investors and Afreximbank's impact fund subsidiary will develop SEZs to produce battery precursors, batteries, and electric vehicles, in both DRC and Zambia (Thomas 2023).

<sup>3</sup> Even if it would involve sourcing sulphates of cobalt, nickel and manganese from elsewhere in the continent, the sequence of precursor production in the DRC, followed by cells manufacturing in Poland and assembly of battery packs in Germany would entail 30% fewer emissions compared to making the precursors in China (BNEF 2021).

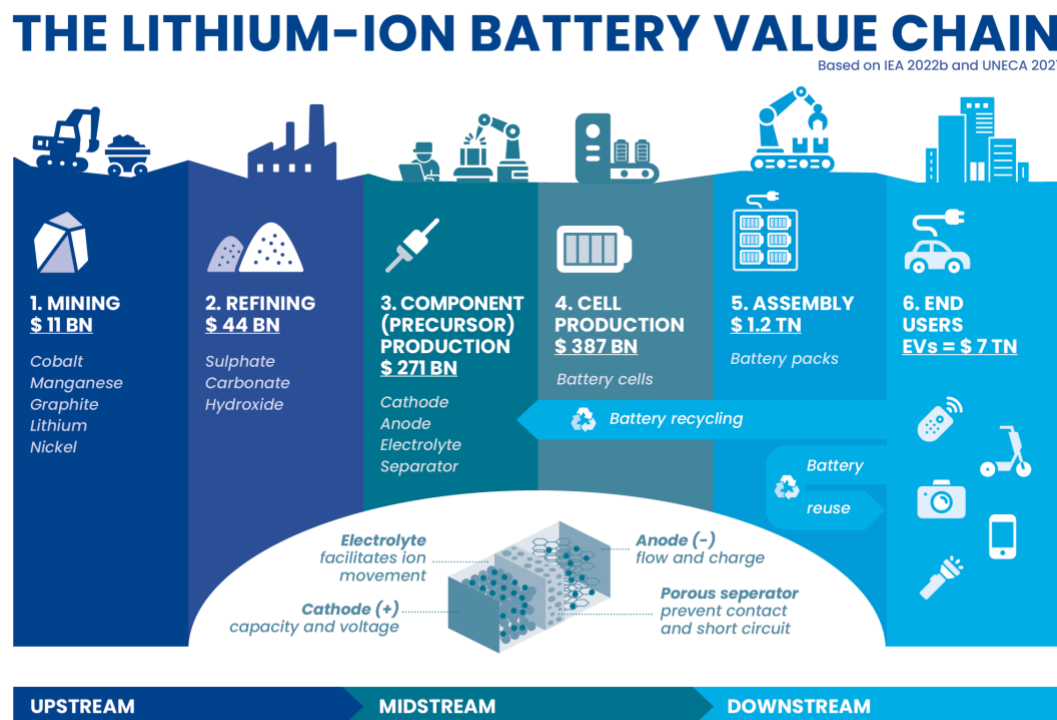
<sup>4</sup> While not organised around them, this analysis draws on the political economy lenses outlined by Byiers and Bossuyt (2016). Outcomes are influenced by **formal institutions** like commitments, policies, laws, and regulations, along with **informal institutions** or the 'rules of the game' that govern the implementation of reforms and initiatives. **Structural factors**, such as natural resources, geography, historical political ties, and embedded economic structures also play a crucial role. Lastly, the interests and incentives of key **actors** at the political, bureaucratic, firm, and civil society levels significantly impact outcomes.

The paper is based on an in-depth literature review and a series of interviews with experts in Europe and Africa. It unpacks the sector characteristics of battery manufacturing (section 2), the geopolitical (section 3), regional (section 4) and national (section 5) factors that shape and influence the potential for African economies to participate in the battery value chain, and outlines some opportunities (section 6) that African countries can seek to utilise to move into more value added activities.

## 2. Sector characteristics: unpacking the battery value chain

Battery production is a complex process with distinct phases of upstream (mining and refining), midstream (cell component production and cell manufacturing) and downstream (assembly and end use) activities (see figure 2). Downstream activities have far higher value-addition than upstream activities – while mining for cobalt, lithium, and nickel is a \$11 billion industry, the electric vehicles (EVs) industry is worth over \$7 trillion (UNECA 2021).

**Figure 2: From mine to EVs - the battery value chain**



### Current capabilities in Africa

Table 1 below outlines the essential processes and activities corresponding to the different stages of the battery value chain, as well as characteristics such as capital intensity or firm concentration. Examining these individually helps understand where current African capabilities lie.

Mining, in general, is a relatively established activity in Africa, constituting over 25% of total exports in at least twenty countries (Usman and Csanadi 2023). However, as Table 1 highlights, it is capital and technology intensive, employing little labour. In many countries, the sector operates as an ‘enclave economy’, dominated by a few international

players relying heavily on imported technology, and limited links to the wider local economy (Radley 2023). Artisanal and small-scale mining, for instance of cobalt in the DRC, is more labour-intensive, yet it accounts for a small proportion of the overall mining production and is often associated with bad working conditions, including child labour.<sup>5</sup>

Refining is an energy-intensive activity. Global refining for battery minerals is highly concentrated in China (see section 3) with little activity in Africa. Notable exceptions include South Africa which has established manganese<sup>6</sup> and aluminium refining (Montmasson-Clair et al. 2021), and has more recently moved into battery-grade nickel-sulphate production (Seccombe 2019). Zambia has a history of copper refining and mineral concentrate production including nickel (Sichula 2023; interview). Recently, lithium processing activities to make concentrates have also begun in Zimbabwe with a similar processing plant planned in Nigeria (Chingono 2023; Lawal 2023).

The next stage in the value chain is the production of battery components – cathodes (including precursors), anodes, electrolytes and separators – and the manufacturing of battery cells. As Table 1 shows this is very energy-, technology- and capital-intensive with a high degree of automation. Economies of scale are key, which explains why just a few firms dominate the market. Most companies that engage in cell and component manufacturing are highly specialised and only produce those components (IEA 2022b). There is currently no or very limited activity in these areas in Africa.

On the other hand, assembly of battery packs using imported cells (mostly from China) is a ‘vibrant industry’ in South Africa (Montmasson-Clair et al. 2021). Firms in this segment often provide integrated solutions for energy storage or niche mobility (e.g. battery-operated forklifts for mining firms, or refrigeration for logistics and transport firms, *ibid*; interview).

Battery recycling is relatively new, with limited end-of-use battery packs and cells to recycle. Some early initiatives are starting to appear such as the planned cobalt recovery from recycled battery materials in Morocco or South Africa’s pilot facility to recover nickel from LIBs in e-cigarettes and phones, both using the hydrometallurgical process (Toto 2022; Linnenkoper 2022).<sup>7</sup> On the other hand, battery reuse in second life applications for the stationary storage market is more common (Revov n.a.).

**Table 1: Battery and cell components manufacturing**

|          | Activity      | Process                                                                                                                                                 | Labour/capital intensity                                                                                                            |
|----------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Upstream | Mining        | Extracting ores from surrounding rocks using explosives for surface deposits or chemical treatment for deeper ores                                      | High technology and capital intensity; few jobs except artisanal mining but bad work conditions                                     |
|          | Beneficiation | Low to high-tech processing to form intermediate products of the raw metal or mineral (e.g. crushing, grinding, separating, chemical or heat treatment) | Can be energy intensive; some beneficiation of cobalt to lower shipping costs; otherwise limited activity in many African countries |
|          | Refining      | Forming high quality, industrial-grade compounds or pure metals and minerals                                                                            | Capital and energy intensive; very limited activity in Africa                                                                       |

<sup>5</sup> About 20% of the overall cobalt production is from artisanal mining (Olander 2023; Ritchie 2023). Artisanal activity has also been noticed in the case of other CRMs (Laing and Pinto 2023). Criminalising the sector risks foreclosing opportunities to productively engage with its creative resilience (Mavhunga 2023).

<sup>6</sup> South Africa’s Manganese Metal Company is the only non-Chinese supplier of electrolytic manganese.

<sup>7</sup> Some firms are engaged in ‘circular’ practices such as Ndola, which does copper recovery from the waste deposits around mines in Zambia (Cotterill 2023).

| Midstream  | Component       | Property                                                                                                                                                                                                                                                                                                                              | Concentration                                                                                             |
|------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
|            | Cathode         | Chemical materials to generate an electric current; determines capacity and voltage; made up of different chemistries e.g. Lithium Nickel Manganese Cobalt Oxide (NMC), Lithium Cobalt Oxide (LCO), Lithium Manganese Oxide (LMO), Lithium Iron Phosphate (LFP) and Lithium Nickel Cobalt Aluminium Oxide (NCA)                       | Seven companies have 55% global capacity                                                                  |
|            | Anode           | Facilitates the flow of the current and determines how quickly the battery can charge; graphite long been used; silicon is an upcoming and cheaper alternative                                                                                                                                                                        | Four companies have 50% global capacity                                                                   |
|            | Electrolyte     | Conduction medium made up of salts and solvent through which ions migrate; technology evolving to use solid state batteries to improve range and charge faster than liquid electrolyte which is flammable but easily enables ion migration                                                                                            | One company responsible for 35% of global electrolyte salt production                                     |
|            | Separator       | Engineered microporous membranes that keep the electrodes (cathode and anode) apart to avoid a short circuit                                                                                                                                                                                                                          | Five companies have 50% global capacity                                                                   |
|            | Cell production | Electrodes are mixed with binder, solvent and additives before coating on aluminium (cathode) or copper (anode) foil, and stacked with a separator in between; require highly controlled clean and dry room conditions to avoid impurities and moisture; research into sodium-ion and vanadium flow batteries as cheaper alternatives | Three companies account for 65% of global production                                                      |
| Downstream | Process         | Activity                                                                                                                                                                                                                                                                                                                              | Application                                                                                               |
|            | Assembly        | Integration of modules, battery management system, electronics and sensors, to make battery packs by encasing in a final housing structure                                                                                                                                                                                            | EV, several other electronics                                                                             |
|            | Recycling       | Process                                                                                                                                                                                                                                                                                                                               | Relative (dis)advantage                                                                                   |
|            | Pyrometallurgy  | Dismantling, smelting to separate metals, recovery (cobalt, nickel and copper), slag removal (aluminium and lithium potentially lost)                                                                                                                                                                                                 | High recovery rates; higher energy intensity and GHG emissions                                            |
|            | Hydrometallurgy | Dismantling, chemical processing to dissolve desired metals, and to solidify and separate metals, purification and recovery                                                                                                                                                                                                           | High recovery and purity; lower energy intensity and emissions; water contamination high operating costs; |
|            | Black mass      | Dismantling and shredding of components, magnetic separation, screening and further separation, recovery of metals for pyro or hydrometallurgy                                                                                                                                                                                        | Low operating costs; lowest risk; contains impurities requiring further refining                          |

Source: Amui and Nkurunziza 2020, IEA 2022b, Raji 2022, The Economist 2023a, Gericke et al. 2021

## Evolving battery technologies and chemistries

Final cost to consumers is a key factor in the battery value chain, directly impacting the uptake of clean technologies. With technological progress and a steep learning curve, the overall price of LIBs declined by over 97% in 1990-2018, falling by 19% with every doubling in capacity (Ritchie 2021). Cost reductions are also linked to increasing vertical



---

integration in the sector.<sup>8</sup> Even so, in EVs, batteries still account for about 40% of the overall cost (ACF and Development Reimagined 2023), and cells account for 70% of the costs of the battery pack, which in turn are made up of raw materials (50%) and manufacturing (50%) costs (Montmasson-Clair et al. 2021).

Technology for different battery chemistries is also rapidly evolving, allowing cost reductions by using cheaper alternatives and improving material efficiency i.e. fewer materials to produce batteries. LFP batteries cost a third less than NMC batteries as they do not use cobalt or nickel in the cathode (Dempsey et al. 2023). As highlighted in Table 1, silicon is an increasingly considered and cheaper alternative to graphite in anode production. Sodium-ion batteries, which are reportedly close to mass commercialisation (Zang 2023), could cut costs significantly by replacing lithium with more abundant sodium (Crownhart 2023).<sup>9</sup>

Though the inputs differ, battery production processes with current technology are similar. The same company can produce NMC or LFP cathodes, or manufacture lithium-ion or sodium-ion batteries (interviews). However, solid state batteries, replacing current liquid electrolytes, or catholyte, combining “cathode chemicals with a solid electrolyte to form a single layer”, require major changes to current production process (The Economist 2023a).

Long-term demand for batteries is largely driven by EVs (McKinsey and GBA 2023), with varying demand for different chemistries, based on cost, energy density (driving range), durability (cycles) and charging speed (Dempsey et al. 2023).<sup>10</sup> As such, firms need to remain agile to respond to demand fluctuations and consumer preferences in order to maximise their market share (interview).<sup>11</sup> This has an impact on investments in the battery value chain, and how and where the different stages take place.

Summary: The LIB battery value chain is highly energy-, technology- and capital-intensive. Apart from mining, there is currently limited participation of African economies in the GVC. New initiatives such as those in the DRC and Zambia will therefore have to overcome some of the challenges presented by current value chain characteristics in order to create suitable conditions for attracting lead firm investments. But these will also be affected by wider geopolitical factors.

### 3. Geopolitical factors: Chinese dominance and EU and US aspirations

Africa is increasingly at the centre of attention among superpowers to secure access to CRMs. These geopolitical dynamics interact with the African governments’ ambitions to develop a LIB value chain as they need external partners for investments, technology and other support. Increased demand for African resources may create new opportunities, but it may also bring risks.

---

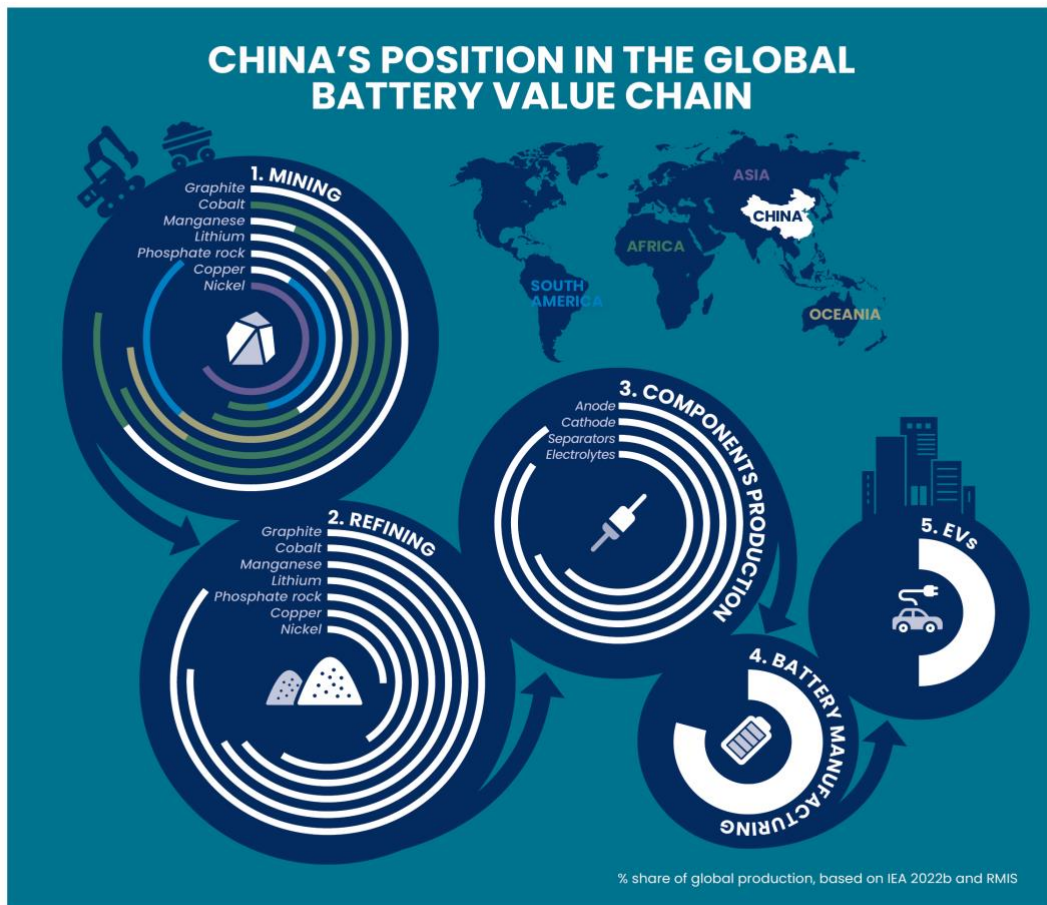
<sup>8</sup> Many battery and automakers such as Tesla, CATL and LG Energy Solution have become increasingly involved in the mining and processing of critical minerals to ensure access to production and avoid supply chain disruptions (IEA 2022c), whereas BYD, the leading Chinese EV maker, was always more vertically integrated.

<sup>9</sup> Cost differences can be significant - \$20,000/MT for lithium versus \$150/MT for sodium (GlobalData 2023). Sodium-ion batteries don’t require copper, cobalt and nickel further reducing production costs, as well as their carbon and environmental footprint (Lockett 2022). Nevertheless, the technology remains in its infancy and the functionality of sodium-ion batteries is not as high as LIBs (AutoDrive Channel 2023).

<sup>10</sup> LFP batteries, developed in China, are less expensive, but also less energy dense than nickel rich battery chemistries (NMC, NCA). At the same time, LFP batteries tend to last many more charging cycles, and are more stable and less prone to catch fire. LFP batteries are well suited for the Chinese megacities, especially for taxis which can be charged regularly, and has been increasingly used for consumer vehicles in Europe. Long-range EVs (e.g. US market), and trucks tend to use nickel-rich chemistries (Bushey and Roeder 2023).

<sup>11</sup> While luxury brands initially heavily relied on nickel rich batteries, Chinese brands have marketed their EVs as mass consumption goods which emphasise affordability and often use LFP batteries (Alloway and Weisenthal 2023).

Figure 3: China's position in the global battery value chain



China controls over 50% of the global LIB market and dominates the supply chain post-mining (see figure 3) and thus has substantial influence on key clean technologies. While it is not the leading producer of battery minerals, Chinese firms control many mining operations through overseas investments (Wang and Allan 2023; Yao and Holden 2021). In the DRC, 15 out of 19 cobalt mines are owned by Chinese firms (Baskaran 2023).<sup>12</sup> Currently, 43% of Africa's minerals and 32% of its ores exports are destined to China (EIU 2023a) through a network of mineral supply agreements that feed its domestic refining industry (García-Herrero et al. 2023). With the exception of nickel<sup>13</sup> and copper, the vast majority of battery minerals are refined in China. It also holds most of the global capacity for battery component and cell manufacturing, accounting for 60% of actual global cell production (Ibid.). Beyond battery manufacturing, China also plays a leading role in end-user applications including EVs and static storage, making it the biggest market for LIBs.

The Chinese government has made long-term, concerted efforts to build critical and cumulative capabilities to successfully localise the battery supply chain, along with linkages across high-tech industries including EVs and renewable energy.<sup>14</sup> Chinese industrial policies have been a combination of horizontal measures (e.g. facilitating

<sup>12</sup> While Chinese investments in Africa are significant, Chinese mining companies represent only 8% of Africa's total mining output (Risi and Doyle 2023).

<sup>13</sup> While Indonesia accounts for a large share of nickel processing, most investments are Chinese (De Decker 2023).

<sup>14</sup> This is exemplified by the Made in China 2025 plan to transform the Chinese economy from an assembler or manufacturer of individual components to a leading production hub of high-tech products. Having struggled with the internal combustion engine in the past (Lin et al. 2023), China's leapfrog to EVs to become a global leader is deemed as one of the most successful cases of industrial policy. EVs have far fewer parts than traditional internal combustion engine cars, and innovation has centred on electric motors, battery technologies, and other electronics. Given the novelty of this technology China was at no particular disadvantage to build tacit knowledge to produce EVs cheaply and well (Smith 2023).

---

R&D across industries), as well as vertical ones (e.g. supporting EV production).<sup>15</sup> These supported supply – incentivising investments by the private sector – but also generated demand – creating a large domestic market for high-tech products (in this case EVs).<sup>16</sup> This approach resulted in intense domestic competition contributing to China’s success in both, scaling production and leading in technological innovation.<sup>17</sup> As a result, there is a high degree of dependence on China for most battery and EV producers worldwide.

At the same time, there are also concerns that battery producers elsewhere may be squeezed due to overproduction in China.<sup>18</sup> Recent export controls by the Chinese government on CRMs (Reuters 2023a) have raised further concerns for battery production elsewhere.

For policymakers around the world, diversifying battery, and ultimately CRM, supply chains away from China is not just a manufacturing question but also one of national security. Overdependence increases their vulnerability and exposure to shocks. The risks are considered especially high given the importance of green technologies and EVs for decarbonisation and green growth ambitions.

The US and the EU seek to ‘de-risk’ CRM supply chains (suggesting a detachment of investments from China) by ‘reshoring’ (boosting domestic production) or ‘friendshoring’ (favouring some partners over others). Consequently, governments there have adopted industrial policies involving subsidies, trade promotion, protectionism, and regulatory interventions to boost domestic production and prevent supply disruptions from hindering their decarbonisation efforts.

The US is using a combination of subsidies with local content requirements as part of the Inflation Reduction Act (IRA), and is looking to friendshore supplies through its Free Trade Area (FTA) partners and the Mineral Security Partnership (MSP) with 13 countries and the EU. The EU, on the other hand, has set itself ‘soft’ targets to extract 10%, process 40% and recycle 25% of annual CRM supply by 2030. Accompanying these policies are the respective foreign investment strategies of the US and EU, namely the Partnership for Global Infrastructure and Investment and the Global Gateway Initiative.

Boosting domestic production in the US and EU is likely to come at a high cost as they compete with lower manufacturing costs and substantial state subsidies in China. On a volume-weighted average basis, battery packs in North America and Europe cost 24% and 33% more, respectively, than those produced in China (Sedgman et al. 2023), where higher construction and labour costs in the former may hinder competitiveness. Achieving self-sufficiency will not only require significant capital investments and subsidies,<sup>19</sup> but technological expertise which remains concentrated in China.<sup>20</sup>

---

<sup>15</sup> Significant resources were dedicated to research and development (R&D) so that by 2016, China overtook the EU in high-impact publications (Gong and Hansen 2023). More importantly, the focus and objectives of key science, technology and innovation policies in China evolved with time going through distinct phases of technological catch-up, a specific focus on EV which facilitated technological accumulation among battery producers, followed by market expansion (Ibid.).

<sup>16</sup> Supply-side measures can be distortionary as they increase production relative to demand. As the surplus is exported, it has raised China’s share in global manufacturing and resulted in trade surplus vis-à-vis partners (Pettis 2023).

<sup>17</sup> According to the leading Chinese EV producer BYD’s founder, the Chinese EV industry is “three to five years ahead of foreign legacy automakers in terms of technology and scale, and as much as 10 years ahead in terms of cost advantage” (White et al. 2023).

<sup>18</sup> In 2023, Chinese battery production capacity is expected to be 200% of domestic demand (Dempsey and White 2023). EV sales in China are flattening as consumer subsidies are removed (Mengnan 2023) and external demand has peaked as a result of unfavourable geopolitical factors (García-Herrero 2023) including lack of brand recognition in the export market (White et al. 2023), and more recently, an EU anti-subsidy investigation into EVs (Blenkinsop 2023). There is a risk of a glut in the battery market (Bae 2023).

<sup>19</sup> The US and the EU would need \$82 billion and \$98 billion, respectively, only to construct the necessary refining and cell-making facilities by 2030 (Sedgman et al. 2023). Achieving self-sufficiency, that is mining and making EVs, would require an additional €382 billion for the EU by 2030 (EC 2022)

<sup>20</sup> For instance, smart battery factory designs and technology for production in the EU come from China (interview).

---

As the US and EU seek to limit their dependence on China, they aim to partner with African countries and invest in CRM processing and battery manufacturing. However, these political commitments are yet to be translated into concrete actions and investment decisions.

## Implications for African economies

The IRA has led to \$70 billion in new investments in the US battery supply chain (Mehdi and Moerenhout 2023). On the supply side, manufacturers can secure credits of maximum \$45/kWh – totaling \$196.5 billion over the next decade (Huang 2023). This can potentially mean a discount of over 30% of their capital investments, and help close the gap with China. To stimulate demand, consumers can get EV tax credits of up to \$7,500, which in turn ensures a growing domestic market. Credits are conditional on sourcing batteries and a percentage of the battery contents from the US or FTA partners. As no African nation, except Morocco, has an FTA with the US, these re- or friendshoring conditions could jeopardise the competitiveness of aspiring African suppliers (The Economist 2023b). Similarly, the MSP does not include any African partners (Pecquet 2023).

The subsidy race between the US, China and EU may also undermine African opportunities and perpetuate existing inequalities. While graphite from Mozambique is crucial for the US, the IRA creates incentives to prioritise processing in the US over Mozambique (Karkare and Medinilla 2023). Industrial policy nationalism may create distortions if the success of a business stems from its ability to ‘capture’ subsidies (Johnston R. 2023). This could further lock African countries into the role of raw materials suppliers, and reinforce existing extractive relationships.

The EU seeks to balance access to CRMs with a sustainability-led agenda involving a regulatory ‘smart mix’ (mandatory and voluntary governance instruments) and transparency-enhancing measures (Müller et al. 2023). Yet, this is difficult to attain in practice. European firms, as they seek to raise productivity to compete with China, complain about the ‘regulatory and reporting burden’ imposed by Brussels (Foy and Johnston 2023).

Resource-rich African nations may be reluctant to join the EU's proposed ‘CRM club’ or similar initiatives as they are wary of being seen as taking sides in the rivalry between the US, China and the EU. The EU also has a very limited track record in investments in African industrialisation and value-added activities (Findeisen 2023). All this raises concerns about the ability of the EU to produce a solid and credible offer to African economies seeking to valorise their resources. It remains unclear today whether and how the EU's geostrategic interests are compatible with African industrialisation objectives (Klingebiel 2023).

A more closed trading system as a result of geopolitical rivalries is likely to particularly disadvantage African countries. While global demand for raw materials may increase, reshoring production of value-added activities to the US and the EU could reduce economic and employment opportunities for African nations, many of which face high unemployment rates. A more radical reshoring of industries to high-income countries could drive an additional 52 million people into extreme poverty, primarily in Sub-Saharan Africa (Brenton et al. 2022).

Instead, prioritising CRM processing in Africa could benefit both external partners and African countries if it can be more cost-effective than processing in the US or the EU due to proximity to raw materials, and cheap clean energy potential (see section 1). That could reduce the risk of overdependence on China while maximising the resilience of CRM supply chains and further lowering the price impact of supply disruptions.<sup>21</sup>

Given these considerations, African countries need to carefully consider external commitments and partnership proposals. For instance, public announcements under the US- and EU-led initiatives, to support CRM production and

---

<sup>21</sup> Compared to fossil fuels supply disruptions in CRMs have a less direct and immediate impact on the economy and prices (IRENA 2023).

---

processing, including an integrated EV battery value chain in the DRC and Zambia, remain vague and not legally-binding (Soulé 2023). Similarly, without complementary investments in manufacturing activities, current EU-US plans to support the development of the Lobito corridor – which could substantially reduce the time to transport copper from the Copperbelt to the Atlantic coast (Cotterill 2023) – may only facilitate raw material exports to the US and EU (instead of China), rather than supporting African ambitions to develop the LIB value chain.

In the DRC and Zambia, these agreements, especially with the US, are perceived as externally-driven raising questions about the agency of the two countries (Byamungu 2023; interview). While the US and EU aim to invest in African mining for battery minerals and in setting up manufacturing facilities, they have a limited track record of strategic investments in the sector, and may struggle to mobilise private investment to back these political announcements due to historically negative perceptions about Africa. Businesses and policymakers have also voiced ‘frustrations’ over the slow pace of Western financing (The Economist 2023b).

Chinese companies reportedly offer integrated solutions at greater speed and lower costs (interview).<sup>22</sup> China is also increasingly seen to respond to the industrialisation ambitions of African countries. In September 2023, on their President’s visit to China, the Zambia Development Agency obtained an investment commitment by Jiangxi Special Electric Motor Company to invest \$290 million for a LIB manufacturing plant in Zambia’s Southern Province (Chen 2023). This and several other Chinese mineral processing projects, including lithium processing facilities in Zimbabwe and Nigeria (see section 2) may signal a shift in Africa-China cooperation towards green development under the 2035 Vision for China-Africa Cooperation (Johnston L. 2023) though their impact remains to be seen.

In the CRM space, Chinese and Western approaches have been quite different. Much EU and US attention has been on conflict minerals, with firms wary of reputational damage, resulting from poor environmental and labour conditions, disengaging in some African countries. Chinese firms in turn have focused on securing economic gains, relying on host country rules and environmental and social standards (de Brier and Hoex 2023). African countries seek to balance these two aspects in an effort to add more value domestically, while ensuring long-term stability of operations. Nevertheless, there is also an increasing convergence. EU and US initiatives are trying to improve their economic offer, while Chinese mining companies are more aware of the costs of environmental and social negligence.

**Summary:** The geopolitical dynamics in the battery value chain suggest that the US and EU moves to de-risk CRM supply chains may offer opportunities for African countries to move up the battery value chain. However, the primary interest of external partners likely remains the sourcing of raw materials from Africa. African countries increasingly insist on greater domestic value addition, but their bargaining power will to a large extent depend on their ability to leverage regional cooperation.

## 4. Regional factors: structural barriers for African participation

Developing an African LIB value chain calls for regionalisation beyond the Zambia-DRC agreements. Apart from facilitating regional trade in the CRMs required for LIBs, a regional supply chain would promote economies of scale and specialisation in the various activities of this value chain (see Table 1 above). At the broadest level, to participate in the supply chain, companies need to source (some of the) inputs from the continent, reduce transport and logistics costs and minimise risks of delays and insecurity. At the same time, a regional battery value chain will be subject to many of the structural barriers that have limited regional industrialisation prospects in the past.

---

<sup>22</sup> According to data analysed by AidData, while projects by Western countries take about 7 years to get from proposal to commencement stage, Chinese projects under the BRI take about 3 years even as they adopt higher ESG standards (Parks et al. 2023).

---

## Infrastructure and connectivity

The infrastructural deficit in Africa poses a major challenge for African battery and component manufacturing. The lack of reliable and affordable electricity in many African countries<sup>23</sup> perpetuates the "pit-to-port model" whereby raw materials are directly exported for processing elsewhere (Joseph 2023). Connectivity and logistics bottlenecks, increase the costs of African minerals (Hill 2022) and, consequently, batteries.

Several projects are underway to develop reliable transport corridors to and from African mineral hubs. This includes an \$850 million project to better connect the Zambia-DRC copperbelt region with the Indian Ocean port of Dar es Salaam in Tanzania (Hill 2023a; Goddard 2022). The development of the Lobito corridor, linking the copperbelt with the Atlantic Ocean port of Lobito in Angola, may turn out to be a competing transport route, impacting its utilisation and competitiveness.

## Link between the *regional* and *global* value chain

African economies currently have limited capabilities in the LIB value chain. While some countries engage in concentrate production and mineral processing, high-value downstream activities like battery manufacturing are nearly non-existent outside South Africa (Montmasson-Clair et al. 2021). Precursor production in the DRC is a small step in a lengthy and intricate process of establishing industrial capabilities for LIB production (WB 2023). The absence of technology-enabled services essential for advanced manufacturing, such as supply chain connectivity, digitalisation, and traceability software, further complicates the development of horizontal linkages in this complex value chain (UNCTAD 2023). Addressing this will require pooling skills from the wider region and international partnerships to bring in the required technology and expertise.

Africa's overall participation in GVCs is limited compared to other regions (Mouanda-Mouanda 2019). Given the need for international partnerships – such as in battery assembly in South Africa, or planned precursor manufacturing in Morocco – the battery RVC will likely remain interconnected with, rather than isolated from, the GVC. Moreover, while resource endowments are important, they are not always the defining factor for investment decisions. The geographical origin of inputs tends to be less important than cost-effectiveness (Shaping Sustainable Supply Chains 2022). Downstream firms will seek to locate processing and manufacturing activities in places with the lowest production cost (energy infrastructure, business environment) and the highest market access (trade agreements, subsidies, domestic demand), whether this is in Africa or not.

## Between cooperation and competition

More broadly, African economies are integrated in *global* value chains, predominantly as suppliers of raw materials (de Melo and Twum 2021). Opportunities for *regional* value chains are underutilised,<sup>24</sup> even if regional trade has a higher share of value added goods (Songwe 2019).

Industrial development through RVCs is a key objective of the AfCFTA, but one that is not easily achieved. Unpacking the dynamics of regional industrialisation requires an understanding of the intricate economic and political factors that have long hindered regional cooperation across the continent. Past challenges in industrialisation and transport corridors have shown that countries struggle to balance cooperation with competition, mainly driven by national interests. For instance, negotiations over rules of origin, which on paper can foster RVCs, involve brinkmanship

---

<sup>23</sup> Firms in sub-Saharan Africa on average pay US\$ 0.22/kWh for electricity which is more than in any other region and twice what firms pay in the US or Europe (Moss and Kincer 2020).

<sup>24</sup> For more see <https://www.integrate-africa.org/rankings/dimensions/productive-integration/>



---

beyond being a legal discussion (MacLeod and Luke 2022) as member states seek to instrumentalise them to serve domestic interests (AfDB 2019). These rules are yet to be finalised for automobiles, which are directly connected to the LIB value chain. Persistent non-tariff barriers, which are known to slow or even inhibit integration (Abrego et al. 2019), also serve a political purpose to protect domestic industries, influenced by lobby and business interests (Herghelegiu 2017; Mathieson 2016).

Although regional agendas are set by national governments, outcomes are shaped by the interaction of interests within and between countries with policy implementation (Byiers et al. 2021). In order to design technically sound and politically feasible policies for an African battery value chain it will be critical to understand these dynamics in greater detail, and navigate them. Opportunities in a regional LIB value chain are likely to be uneven, based on critical capabilities and linkages (Agarwal et al. 2022; Cloete et al. 2023). This can create bottlenecks in implementation, and jeopardise future investments.<sup>25</sup>

While some (South African) firms have shown interest in regional collaboration for battery production, coordination challenges across regional partners are already evident in the value chain. In 2020, a Zambian firm had to suspend cobalt processing operations due to a cobalt feedstock shortage following a 5% tariff imposed by the Zambian government on imports from the DRC (Reuters 2020). While the tariff has been lifted since, this case highlights the tensions between regional cooperation and competition as countries aim to retain profits and add value within their national boundaries (Byiers et al. 2018).

Summary: While the presence of raw material across different African countries may provide an opportunity to add more value by engaging in RVCs supported by the AfCFTA, this is unlikely to happen without resolving some of the existing structural (infrastructure, small economic size), institutional (legal and governance), and coordination (competition versus cooperation) challenges that have limited regional industrialisation in the past.

## 5. National factors: industrial policy and linkages

Regional cooperation is essential to reach critical scale for any African industry, yet most investments and initiatives take place at the national level. As several countries are seeking to enter the battery value chain, it is important to unpack the underlying national interests, including those of political leaders, bureaucrats, firms, labour, among others. This section looks at the importance of sector expertise and coordination, industrial policies and the emergence of resource nationalism in some African countries.

### Jobs, productivity and skills

A primary goal of industrialisation in African countries is job creation. Battery production, however, is highly automated (Saiidi 2019). Labour represents a small portion of overall expenditures,<sup>26</sup> though the potential for indirect jobs can be significant (interview).

African economies are characterised by low productivity, limited diversification and a large informal sector (Dinh 2023). The LIB value chain offers some opportunities for value addition, but is unlikely to address the economic dualism where high-productivity firms coexist with a vast and low-productivity informal sector.

---

<sup>25</sup> Lessons can be drawn from the failed attempt to set up a regional coltan refinery in South Africa (Diene et al. 2022) where countries were unable to agree on a fair share of benefits for supplying ore to the refinery.

<sup>26</sup> In China, apart from the limited labour in R&D, there is a need for some technical staff and engineers at the middle level to maintain oversight while low-skilled labour is being replaced by robots (interview).

---

Skilled labour (e.g. chemical and electrical engineering) is key, both for vertical upgrading (moving up the value chain) and creating new horizontal linkages, yet it is lacking in African countries. This is not just a technical question of capacity/skills building, but also requires initiatives to overcome challenges of rent-seeking and fraud as a result of limited productive capacity and demand by firms themselves (Khan et al. 2019).

A 2023 review of African countries' productivity, export competitiveness, diversification, technological upgrading and human resources finds that economic transformation has been low, with widening gaps between African countries and early transformers in Asia and Latin America. In fact, African countries overall have become less diversified and competitive between 2000 and 2020 ([African Transformation Index - ATI](#)).

## Balancing the competing objectives of industrial policy

Industrial policies will be crucial for getting a capital and technology intensive industry like LIBs off the ground. Rather than being a policy document, smart industrial policies need to bring about 'strategic coordination' among different actors and interests (Andreoni and Chang 2019). To be functional, these policies need to be well adapted to the African context to facilitate learning-by-doing (Stiglitz 2017). 'Mission-oriented industrial policy' can crowd in strategic investments for the green transition (Mazzuccato 2022). It can guide businesses by disciplining firm practices, and rewarding complementary investments, but its effectiveness hinges on being selective and strategic to avoid distortions or rent-capture (Andreoni and Roberts 2022). At the same time, these policies tend to be *national* rather than *regional*, highlighting the difficulty in coordination between countries (see section 4).

Given their inherently political nature, industrial policies are often a compromise between different objectives, including job creation, mining revenue maximisation, domestic value addition, catch-up industrialisation, regional integration, and minimisation of negative climate-related externality. Beyond realistic assessments of objectives such as job creation (see above), coordination failures and trade-offs can create tensions, suggesting the need to balance competing objectives (see box 2 on DRC below).

As geopolitical competition intensifies, major players like the US, EU, and China are increasingly deploying nationalist industrial policies with substantial subsidies for the LIB value chain (see section 3). However, despite their critical role in building domestic capabilities through strategic coordination, Juhász et al. (2023) find 'virtually no industrial policies in low income countries'. Even though subsidies may not be a viable option for many African countries, robust, strategic, and context-specific industrial policies, complemented by efforts to strengthen state capabilities, can address entrenched inequalities and bring benefits from new and green windows of opportunity.

Lessons can be drawn from the emerging battery assembly industry in South Africa, and adapted to leverage domestic capabilities in other countries with CRMs. Several companies have developed expertise in the manufacturing of specific components, parts and systems as well as the assembly of battery packs for the domestic market as well as exports (Montmasson-Clair et al. 2021). Some others are exploring the potential to manufacture LIB cells locally (Whitehouse 2023). The focus is currently on developing expertise in battery pack design and assembly, particularly for industrial, energy and storage uses, and not the automotive sector, which is where the majority of long-term demand is anticipated (Montmasson-Clair et al. 2021).

Apart from leveraging downstream activities, Cloete et al. (2023) also illustrate how some countries like Australia, Chile, Indonesia, South Africa and Botswana have successfully developed their upstream resources by following very different strategies but which were appropriate to their local context. These strategies included a goal of bringing in



complementary investments to build productive capacity, rather than resorting to resource nationalism. This is illustrated well by the case of Morocco.

### Box 1: Lessons from Morocco

Morocco has transformed itself from a natural resource exporter (phosphate rock) to a major manufacturer of fertilisers, and more recently cars and automotive components, producing close to 500,000 new vehicles per year, primarily for the European market. The Moroccan mining group Menagem plans to supply cobalt sulphate to Renault-Nissan (Hajbi 2023), and produce cobalt from recycled batteries in partnership with Glencore (Toto 2022).

The country is also leveraging its recent and rapid growth in automotive manufacturing, and trade relations with the US and EU to position itself in the global battery value chain. Morocco's automotive industry, among Africa's largest manufacturing hubs, along with South Africa, has become more important than its phosphate exports (North Africa Post 2023). Partnerships with auto suppliers and OEMs for over a decade facilitated technology transfer, leading to 220,000 industry jobs and 60% local production (Pilling 2021).

In 2023, LG Chem and Huayou Cobalt announced plans to produce LFP cathode materials starting in 2026, as well as build a new lithium conversion plant. More recently CNGR also announced similar plans (Argus 2023). These projects specifically target the US market, as Morocco's FTA status would make the outputs eligible for the full US tax credits for EV consumers (Yang 2023).

Several other plans are being considered. China's Tinci group announced plans to relocate an electrolyte facility from the Czech Republic to Morocco (Pacot 2023), while the country signed an agreement with Gotion High-Tech to develop the continent's first battery gigafactory with a capacity of 100 gigawatts, backed by an investment of €6 billion (Millan 2023).

The concentration of plans in Morocco illustrates that the country is able to leverage its automotive linkages and market access in both the EU and US to attract new, mostly Chinese investments to lay the foundations of a new EV supply chain (Jeong and Allan 2023).

Dedicated and export-oriented industrial policies helped build productive capabilities with a steep learning curve by exposing domestic firms to international competition. The country has leveraged its proximity to the EU, complemented by policy interventions to maximise the benefit from trade openness, infrastructure development and skills enhancement tailored to the needs of, and in close consultation with, the private sector (Islah 2023). A clear vision for the sector was complemented by 'embedded autonomy' whereby collaboration between different stakeholders was fostered without succumbing to special interests or rent-seeking (Hahn and Auktor 2018).

## Experiments with resource nationalism

Unlike Morocco's experience, some African countries are increasingly resorting to resource nationalism, exerting stronger control over their resources to ensure that more value is retained in the country. Zimbabwe and Namibia, for example, have both restricted the export of raw lithium in 2023 (Africanews 2023; Reuters 2023b). This more interventionist strategy is driven by the desire to seek a fairer share of value in the supply chain and avoid getting locked into a low low value-added and extractive pathway.

However, a government ban on raw material exports does not guarantee increased domestic value addition due to several uncertainties in the minerals sector. To begin with, the high degree of concentration among a limited number of large multinational companies raises doubts about the potential involvement of domestic/regional actors in productive activities (Opalo 2023a). Moreover, several governance, environmental, social, and public health challenges in the mining sector limit the benefits from this economic activity.<sup>27</sup>

<sup>27</sup> Mining (in many cases foreign) corporations are often associated with mismanagement, rent-seeking, corruption, and inefficiencies (AlJazeera 2022; Schoenberg and Fernyhough 2023; Anderson 2023). These governance challenges are further compounded by others like limited community consultations for mining projects and conflict minerals (Cloete et al. 2023). Though less destructive than fossil fuels (Ritchie 2023c), mining for battery minerals poses environmental challenges, including water and land use issues and/or waste generation (Andreoni and Simons 2022; Cloete et al.

---

## Box 2: Resource nationalism in the DRC

The DRC recently cancelled the operating rights for 29 mining companies in 2023. Although the government did not provide any official explanation for the decision, its intention is likely a desire to 'regain control' of the sector (Ben Yahmed 2023) and seek a fairer share of mining revenues (Sguazzin 2023). At the same time, this uncertain business environment risks discouraging investments. Similar to industrial policies, this shows the need to balance competing objectives of revenue generation and investment promotion.

Policies to develop resources further through processing and manufacturing need to be well targeted. Local content requirements, while potentially fostering value addition, are insufficient if they do not identify the appropriate actors. Mining companies do not engage in manufacturing and therefore bringing these activities would require extensive negotiations with other sets of actors.

Further, different policy objectives may not all be achieved at the same time. For instance, value addition may not always generate much additional revenue. Greater value addition through copper-based manufacturing in the DRC to produce US\$ 500 million worth of products would result in US\$112 million in additional exports and 1,300-2,000 in additional employment opportunities but only US\$9 million in annual taxable revenue as margins are small (WB 2023).

Other uncertainties emanate from market dynamics. Supply and demand mismatches lead to price volatility.<sup>28</sup> While there are uncertainties in supply to the international market due to time lags with mine development (Ritchie 2023b; Money 2023; Parkin and Dempsey 2023),<sup>29</sup> emerging alternative technologies further complicate the picture from the demand side (ETC 2023).

Mineral refining can create opportunities for value addition, but it is also a highly complex, energy intensive and polluting activity (Sedgman et al. 2023; Pickles 2023). This means physical infrastructure, but also a robust regulatory framework for waste management and environmental standards are essential.

Capital-intensive industries typically take a long time before turning a profit. This makes government support in the form of subsidies essential (Shih 2023), yet it is often unavailable in African countries faced with exorbitant capital costs.<sup>30</sup> Even if firms are given financial incentives to offset certain costs, operating costs which are determined by logistics, electricity, and imports, tend to be high across Africa. Given all these (high) risks of doing business, most African countries score low on attractiveness for resource investments, despite their potentially large reserves (EIU 2023b).

Beyond export restrictions, complementary investments, therefore, are essential to create an attractive environment for local manufacturing and competitive exports. Past failed attempts at resource nationalism, like Tanzania's copper smelting ban, serve as cautionary tales (Diene et al. 2022). On the other hand, lessons can also be learned from countries like Chile, which have taken a more state-led approach to develop respective lithium and nickel processing capacities (Beattie 2023; Kim 2023).

While this paper largely focuses on the *supply* dynamics in the battery value chain, the *demand* side is also important. Domestic battery demand in Africa is relatively low, which can in turn become a barrier for African manufacturing.

---

2023), social sustainability concerns like human rights violations, including child labour (e.g., cobalt, Ritchie 2023a) as well as serious public health hazards (Pickles 2023).

<sup>28</sup> According to data by Benchmark Market Intelligence, the price of cobalt plunged 46% from about \$60,000/metric tonne to \$32,000 due to a surplus of over 17,000 metric tonnes in the international market (Desai 2023).

<sup>29</sup> Achieving net-zero emissions by 2050 requires at least a sixfold increase in the world's supply of critical minerals from new and existing mines, even as innovation reduces demand (IEA 2022c). Even if there are enough reserves in the world to satisfy this demand, whether this can be done within the timeframes required is less clear.

<sup>30</sup> With investors and banks shying away from expanding the expansion of e-mobility solutions despite demand for them (Siele 2023), securing financing for the production of intermediate goods like LIBs is arguably even more difficult.

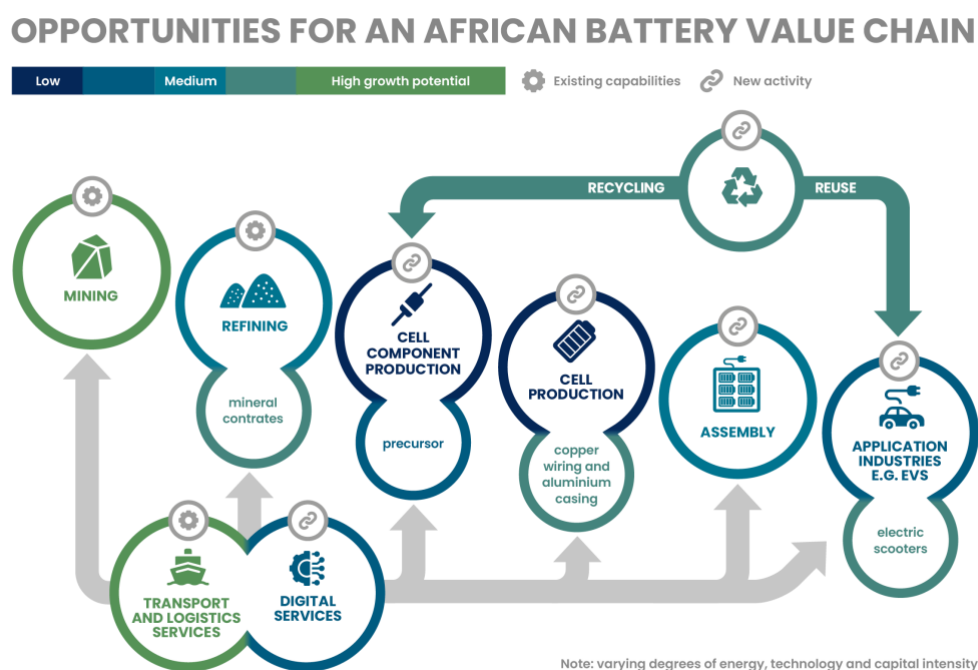
Viable EVs and EV components manufacturing needs (i) a large domestic market, (ii) periphery to a large market, or (iii) a regional market (Agarwal et al. 2022). Yet, the high cost of EVs relative to the average income in many African nations limits consumer demand (Cash 2022),<sup>31</sup> while consumer subsidies are out of reach for most African governments. Additionally, imports of second-hand vehicles for low-cost mobility further constrain the market for new EVs.<sup>32</sup> Given the lack of policy and incentives to boost demand and production, the business case for Original Equipment Manufacturers (OEMs) to shift EV operations to countries like South Africa is challenging (Montmasson-Clair et al. 2021). Complexities surrounding transportation and associated costs suggest that a policy solely focused on exporting cells or batteries may not be viable without sufficient local demand (Ampofo 2023). Nevertheless, energy storage solutions and electric two-wheelers are forecast to drive demand for batteries in Africa.

**Summary:** The ambitions for a regional battery value chain will depend on policies implemented at the national level which requires a strategic use of limited available resources to prioritise rapid building of domestic capabilities while balancing political, social and economic objectives of national actors as well as international partners.

## 6. African opportunities in the battery value chain

The preceding sections have outlined various factors influencing an African LIB value chain, encompassing both positive and negative aspects. If some of these challenges can be overcome, there are some opportunities worth noting, emphasising the need to proactively identify openings to enter these spaces and become competitive. Figure 4 provides an overview of these opportunities, identifying existing capabilities and a low, medium or high growth potential.

**Figure 4: Opportunities for an African battery value chain**



<sup>31</sup> Despite being the leading market for EVs in Africa, there are only about 6,000 of them on the road in South Africa or 0.2% of the total; in Kenya the figure is at an estimated 350 out of a total of 2.2 million cars (Cash 2022).

<sup>32</sup> Even in the US market, the sale of used EVs surpasses that of new ones (Suarez 2023).

---

**Mining:** Sustainability considerations may favour some African producers. For instance, Mozambique's natural graphite has a lower carbon footprint than synthetic graphite commonly used in China.<sup>33</sup> Similarly, the higher copper grade in Kamoa-Kakula in the DRC (6% to 11%) reduces waste and environmental impact compared to Chile (less than 1%) to produce the same amount of copper (Sanderson 2023a).

**Refining:** This holds promise if energy, connectivity, and skills are readily available. This requires a strategic two-pronged approach to invest in domestic capacity and address regional coordination challenges to engage in regional supply chains. Refined materials are inputs into a wide range of industries, beyond just battery cells.

**Component and cell production:** While battery components and cell manufacturing is technologically complex, opportunities exist in producing inputs required for these components such as precursors, or copper wiring used in battery manufacturing as well as other products like electric motors, transformers, and renewable energy. These activities are less energy-intensive than refining (WB 2023).

**Battery pack assembly:** There are opportunities further downstream, as shown by South Africa's battery assembly industry. This is in line with historical industrialisation trends where assembly activities provide opportunities for consolidation of skills before progressing to intermediate inputs and deepening value addition (Dinh 2023).

**Downstream applications:** Stimulating downstream applications could boost the currently modest demand for batteries, thereby strengthening the case for an African LIB value chain. Battery demand in Africa is set to surge, driven in part by utility-scale storage and decentralised renewable energy applications (Agege 2022; interview).<sup>34</sup> The rising interest in e-mobility, fueled by numerous startups and supported by leaders (ElectricBee n.a.; Kuhudzai 2023a), is leading to assembly activities for electric buses and motorcycles as seen in Kenya (Ongaji 2023; Kuhudzai 2023b). Using African batteries into African-made electric two-wheelers can be advantageous because of (a) the existence of a large regional market, (b) relatively low-tech production requirements, and (c) fewer concerns related to second-hand imports, unlike passenger car EVs (Agarwal et al. 2022; Black et al. 2018; Toll 2023).<sup>35</sup> Insights from Bolivia's Quantum Motors and Morocco's planned Neo EVs, emphasising affordability and simplicity in African-designed EVs can also boost future demand (Schröter 2021; Fernández 2022).

**Horizontal linkages:** Technology-enabled services, including digital services can create jobs and generate externalities in the LIB value chain. While digital services for smart manufacturing are rare in Africa (Karkare 2023), Kenya's tech leadership offers potential in this regard.

**Repurposing and recycling:** There are opportunities to introduce circularity in the typically linear battery production process. Currently, there are stronger financial incentives for repurposing compared to recycling due to the high costs associated with the latter. Used EV batteries retain over two-thirds of their usable energy storage and can be reused for diverse applications, like static renewable energy storage in rural areas (To 2022) or reducing EV manufacturing costs instead of producing new batteries from scratch (Cash 2022). Recycling industries may hold future opportunities, as more end-of-life packs are set to come on the market in the coming years, and as EU regulations create demand for recycled battery content (CoEU 2023b).<sup>36</sup> Establishing local collection and sorting

---

<sup>33</sup> Synthetic graphite is refined from hydrocarbon materials such as coke (IEA 2022c). Natural graphite anodes are 55% less carbon intensive than those made from synthetic graphite (BenchmarkMinerals 2022).

<sup>34</sup> For instance, with an increasing uptake of battery energy storage solutions in South Africa, the demand for batteries is set to rise (Gordhan 2023), making the case for domestic/regional production.

<sup>35</sup> 20% of the world's registered two-wheelers are in Africa. In some countries, motorcycles represent over 80% of the registered vehicles. Electric motorcycles are a proven lower-cost alternative, even if the initial costs can be high (Ayetor et al. 2023).

<sup>36</sup> By 2040, recycled copper, lithium, nickel and cobalt from used batteries could reduce primary supply requirements for these minerals by around 10% (IEA 2021). This is crucial given that mineral demand is forecast to grow several fold during the same time (WB 2023).

---

infrastructure is essential for a consistent battery feedstock, along with robust regulatory frameworks to prevent the import or dumping of unsuitable batteries for recycling.

## 7. Recommendations

The prospects for an African LIB value chain are shaped by a wide range of factors including sector-specific, geopolitical, regional, and national political economy dynamics. Although green industrialisation, as illustrated by the LIBs value chain, creates new possibilities in Africa, it also adds a new layer of complexity to the prevailing challenges of industrial development. Based on this initial mapping study, we outline five sets of recommendations for African countries and their partners to actively participate in the creation of a regional LIB value chain.

### Improve Africa's true mining potential

Africa's mining sector can drive socio-economic development if the capacity, governance and infrastructure in the sector are improved. Priority should be given to the identified areas under the Africa Mining Vision which include (i) improving the quality of geological data, (ii) improving contract negotiation capacity, (iii) improving the capacity of the mineral sector governance, (iv) improving the capacity to manage mineral wealth, (v) addressing infrastructure constraints and (vi) elevating artisanal and small-scale mining (Andreoni and Simons 2022).

The upcoming African Green Minerals Strategy by the AU provides a further framework for supporting green industry and establishing a larger presence in clean-tech supply chains and is structured around four pillars: (i) advancing mineral development, (ii) investing in human capital and technological capacity, (iii) building value chains, and (iv) promoting resource stewardship (Kitaw 2023).

Challenges within each of these pillars must be addressed. For example, despite potential benefits, artisanal mining is often deemed a hazardous, illegal, and overall undesirable activity, robbing the state of tax revenues, and mining companies of their minerals. Firms, seeking responsible mining practices, also tend to avoid artisanal suppliers.<sup>37</sup> Yet a pragmatic collaboration between industrial and artisanal miners is not impossible,<sup>38</sup> and can create some opportunities in an otherwise bleak economic environment.<sup>39</sup> National initiatives, like the DRC's plan to establish a copper-cobalt processing plant to capture artisanal output, can help address challenges in this sector (Kavanagh 2023).

International initiatives such as the EU's AfricaMaVal project, a multistakeholder initiative to develop the responsible sourcing and sustainable development of African CRMs, can be a basis to develop new forms of cooperation.<sup>40</sup>

### Engage in smart, targeted industrial policies

Industrial policies are critical for coordinating efforts across activities and countries in the battery value chain. National and regional policies need to strategically consider various aspects to promote learning-by-doing. These include:

- cultivating relations with foreign partners through supplier contracts and joint ventures
- bridging knowledge and financial gaps to address binding constraints

---

<sup>37</sup> According to Dempsey (2023), "The \$7.7tn club of miners, car manufacturers and electronics makers — including Glencore, Volkswagen, Microsoft and Apple — who belong to the Responsible Minerals Initiative continue to rigidly exclude artisanally mined cobalt from what they consider "responsible" sources".

<sup>38</sup> Processing of cobalt mined by artisanal workers is sometimes done locally by operating mines in the country to support their own mined supply (Jamasmie 2018).

<sup>39</sup> In the DRC, an artisanal cobalt miner could earn \$400 compared to about \$100 as a teacher (Ritchie 2023a).

<sup>40</sup> See <https://africamaval.eu/the-africamaval-project/>

- sequencing reforms starting with (low-skilled, employment-generating) assembly to move into (high skill-, capital-, and technology-intensive) intermediate goods
- balancing industrial policy objectives within and between countries, ensuring accountability to prevent unproductive rent-seeking
- providing time-bound and conditional support to firms to enhance productivity and competitiveness
- employing an adaptive mix of horizontal and vertical policies to bring about complementary investments (as in China and Morocco, see section 3 and 5).

A dedicated battery regionalisation strategy can outline the potential distribution of activities in an African battery value chain, building on existing endowments and capabilities. Developmental governance of CRMs, as elaborated by Andreoni and Roberts (2022) – by negotiating mineral development as part of an industrial policy for structural transformation without being captured by vested interests – can promote greater domestic value addition and equitable distribution across the RVC. Given that the LIB value chain is a priority under the AfCFTA, its Secretariat is well-positioned to guide regional cooperation and coordination of industrial policies.

### Ensure market access

Export markets are key for a viable African battery value chain. Currently only Morocco has an FTA with the US, with calls to extend IRA credits to minerals produced in the 36 countries that are part of the Africa Growth Opportunity Act (AGOA) (Schneidman and Songwe 2023). Extending membership in initiatives such as the US' MSP or the proposed EU CRM Club to select African countries could also enhance market access provided this does not impinge on African geopolitical priorities.

Beyond state-state agreements, collaborating with specific firms offers another avenue for securing market access. For instance, a recent agreement between a Kazakh firm in the DRC and a US counterpart demonstrates the potential for supplying cobalt hydroxide from the DRC to the US for battery-grade cobalt sulphate production in line with IRA requirements (Interfax 2023).<sup>41</sup> Additionally, there are also negotiations between the US and third countries like Saudi Arabia to buy stakes in African mining operations, such as cobalt in the DRC and give US firms access to some of the production (Reuters 2023c).

### Geopolitical positioning

Despite power differentials, African countries should seek to ensure that greater competition among its partners leads to more development opportunities *within* the continent (Andreoni and Roberts 2022). African leaders should proactively engage with partners to attract investment in the LIB value chain, by capitalising on their domestic and collective capabilities, and working towards creating pockets of efficiency.

Partners like the EU and US in turn should avoid giving the impression that their interests solely revolve around resource procurement or competition with China. This may intensify existing distrust, fostering the belief that external agendas do not contribute to genuine African development. Instead, CRM partnerships should be used to find a better balance between African and Western priorities, and between economic considerations and environmental and social sustainability. The starting point for these initiatives should be concrete investments and business ventures, beyond references to regulations and standards, often unilaterally set by external partners.

Given the competitive political environment in Africa, political leaders value quick financing and efficient project implementation (Opalo 2023b). This needs to be taken into account in partners' engagements with African countries to balance them with their own focus such as institution building. To reconcile the tension between African

<sup>41</sup> The Eurasian Resources Group's holding company was under criminal investigation in the United Kingdom over allegations of bribery and fraud in its mining contracts in Africa until the case was dropped in August 2023 (Davies and Pegg 2023).

---

development priorities and partners' geostrategic interests in CRMs, co-creating proposals and initiatives that align goals and provide tangible benefits for all parties is essential.

### **Involve the private sector**

The current discourse on the development of an African LIB value chain or efforts by partners to reduce reliance on China is largely driven by political leaders. However, as the private sector is the primary actor in the value chain, understanding their perspectives is crucial. For example, despite being a priority RVC under the AfCFTA, what obstacles do private firms see in translating this priority into reality? Additionally, in the context of the EU or the US seeking entry into the mining sector to secure CRM access, can private mining companies, motivated by short-term profits, make the required investments and compete effectively with Chinese (often state-owned) enterprises operating on a longer-term horizon, particularly during periods of low mineral prices (Sanderson 2023b)? A US-based copper mining firm for example sold its mine in the DRC to a Chinese counterpart as recently as 2020 (Hill 2023b).

### **Areas for further research**

While this mapping outlines broad issues affecting the prospects for an African battery value chain, we identify several areas for further research. These encompass both technical aspects and, as emphasised in this paper, political economy dynamics which eventually influence outcomes. These areas include:

- legal aspects of the AfCFTA, particularly rules of origin, to facilitate regional trade within the LIB supply chain
- trade facilitation and logistics, including corridor competition (e.g. Lobito corridor to Angola vs. Central corridor to Dar es Salaam)
- industrial policy to create efficiency hubs and facilitate battery manufacturing in Africa
- EU-Africa cooperation on CRM development and supply chain links between firms
- trilateral cooperation between the EU, China, and Africa on CRM development
- leveraging the EU Green Deal and decarbonisation objectives to establish manufacturing activities in Africa, such as recycling in line with CRMA stipulations
- EU-Africa cooperation to promote context-driven and effective environmental, social, and governance (ESG) norms and principles.



---

## References

- Abrego, L., de Zamaroczy, M., Gursoy, T., Nicholls, G.P., Perez-Saiz, H. and Rosas, J.-N. 2020. [The African Continental Free Trade Area: Potential Economic Impact and Challenges](#). Staff Discussion Notes. Washington, DC: International Monetary Fund (IMF).
- ACF and Development Reimagined. 2023. [Unleashing Africa's Untapped Potential for Environmental Goods Manufacturing](#). Cape Town: African Climate Foundation (ACF).
- AfCFTA and UNDP. 2021. [Which Value Chains for a Made in Africa revolution](#). The Futures Report 2021. New York, NY: United Nations Development Programme (UNDP).
- AfDB. 2019. [African Economic Look 2019](#). Abidjan: African Development Bank Group (AfDB).
- Afreximbank. 2023. [Afreximbank and ECA sign Framework Agreement towards establishing Special Economic Zones for the production of Battery Electric Vehicles in DRC and Zambia](#). Press Releases. Cairo: Africa Export-Import Bank (Afreximbank).
- Africanews. 2023. [Zimbabwe bans all lithium exports](#). Lyon.
- Agarwal, P., Lemma, A., Black, A., Mkhabela, V. and Stuart, J. 2022. [The AfCFTA and the Automotive Value Chain](#). Research Report. London: Overseas Development Institute (ODI).
- Agege, P. 2022. [Challenges Facing the Battery Industry in Africa & Solutions](#). San Francisco, CA: BatteryBits (Volta Foundation).
- AlJazeera. 2022. [Glencore to pay \\$180m over DRC corruption claims](#). News, Corruption. Doha.
- Alloway, T. and Weisenthal, J. 2023. [The Chinese EV maker that's selling more cars than Tesla](#). New York, NY: Bloomberg.
- Ampofo, K. 2023. [Cobalt suppliers up their game to cash in on EV rush](#). London: BloombergNEF (BNEF).
- Amui, R., Nkurunziza, J. 2020. [Special issue on strategic battery raw materials](#). *Commodities at glance*, 13. Geneva: United Nations Conference on trade and Development (UNCTAD).
- Anderson, P. 2023. [Cobalt and Corruption: The Influence of Multinational Firms and Foreign States on the Democratic Republic of the Congo](#). Research articles. *Journal for Global Business and Community*, 14(1).
- Andreoni, A. and Chang, H.-J. 2019. [The political economy of industrial policy: Structural interdependencies, policy alignment and conflict management](#). *Structural Change and Economic Dynamics*, 48: 136-150. Amsterdam: Elsevier, Science Direct.
- Andreoni, A. and Roberts, S. 2022. [Geopolitics of critical minerals in renewable energy supply chains](#). Cape Town: African Climate Foundation (ACF).
- ANRC. 2022. [Approach Paper towards preparation of an African Green Minerals Strategy](#). Abidjan: African Development Bank Group (AfDB).
- Argus. 2023. [China's CNGR to build battery CAM, LFP plant in Morocco](#). Blog. London: Argus Media.
- AutoDrive Channel. 2023. [Sodium Ion VS Lithium Ion. What is the difference?](#) YouTube video.
- Ayetor, G.K., Mbonigaba, I. and Mashele, J. 2023. [Feasibility of electric two and three-wheelers in Africa](#). *Green Energy and Intelligent Transportation*, 2(4). Amsterdam: Elsevier, ScienceDirect.
- Bae, S. 2023. [Battery cell prices plummet amid supply glut in China, weak EV demand](#). Batteries. *The Korea Economic Daily, global edition*. Seoul.
- Baskaran, G. 2023. [A Window of Opportunity to Build Critical Mineral Security in Africa](#). Washington, DC: Center for Strategic and International Studies (CSIS).
- Beattie, A. 2023. [EU seeks to tone down the imperial style in search for critical minerals](#). Opinion Trade Secrets. Financial Times. London.
- Ben Yahmed, M. 2023. [DRC: Cancelling operating rights of 29 mining companies stirs controversy](#). Huge Blow. *the africa report*. Paris.
- BenchmarkMinerals. 2022. [ESG of graphite: how do synthetic graphite and natural graphite compare?](#) London.

- 
- Black, A., Barnes, J., Makundi, B. and Ritter, T. 2018. [Electric two-wheelers in Africa? Markets, production and policy](#). Bonn: German Institute of Development and Sustainability (IDOS) – ex DIE.
- Blekinsop, P. 2023. [EU to investigate 'flood' of Chinese electric cars, weigh tariffs](#). London: Reuters.
- BNEF. 2021. [The cost of producing battery precursors in the DRC](#). London: BloombergNEF (BNEF).
- Brenton, P., Ferrantino, M.J. and Maliszewska, M. 2022. [Reshaping Global Value Chains in Light of COVID-19: Implications for Trade and Poverty Reduction in Developing Countries](#). Books. Washington, DC: World Bank. License: CC BY 3.0 IGO
- Bushey, C. and Roeder, O. 2023. [US electric vehicle batteries poised for new lithium iron age](#). Batteries. *Financial Times*. London.
- Buyers, B. Woolfrey, S. and Karaki, K. 2018. [The political economy of regional industrialisation strategies](#). ECDPM discussion paper 237. Maastricht: ECDPM.
- Byamungu, C.G.N. 2023. [He U.S.-Zambia-DRC Agreement on EV Batteries Production: What comes next?](#) Commentary. Washington, DC: Center for Strategic and International Studies (CSIS).
- Byiers, B. and Bossuyt, J. 2016. [A 'how to' note: Doing regional development differently – A political economy analysis framework for identifying drivers and constraints to regional integration](#). ECDPM Guide. Maastricht: ECDPM.
- Byiers, B., Apiko, P. and Karkare, P. 2021. [The AfCFTA and industrialisation: From policy to practice](#). ECDPM discussion paper 314. Maastricht: ECDPM.
- Cash, K. 2022. [Everything you need to know about African EV manufacturing](#). Memo. Washington, DC: Energy for Growth Hub.
- Chen, H. 2023. [China and Zambia: A New Chapter Beyond Debt? The Zambian president's visit to China moved the relationship beyond debt and reset to a focus on growth](#). China Power, Diplomacy, East Asia. *The Diplomat Magazine*. Tokyo.
- Chingono, N. 2023. [Zimbabwe lithium export earnings treble as projects take off](#). London: Reuters.
- Cloete, D., Joseph, A., Jentel, L., Wolf, N., Mzinyati, L. and Benkenstein, A. 2023. [Exploring the Critical Minerals Ecosystem in SADC: Country Barriers and Enablers](#). Reports | Energy and Just Transition, Foresight, Natural Resources. Johannesburg: South African Institute of International Affairs (SAIIA).
- CoEU. 2023a. [Council and Parliament strike provisional deal to reinforce the supply of critical raw materials](#). Press release. Brussels: European Council, Council of the European Union (CoEU).
- CoEU. 2023b. [Regulation of the European Parliament and of the Council concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation \(EU\) 2019/1020 and repealing Directive 2006/66/EC. Legislative acts and other instruments](#). Brussels: European Council, Council of the European Union (CoEU).
- Cotterill, J. 2023. [Zambia's plan to dig its way out of debt with a copper rival](#). The Big Read, Zambia. *Financial Times*. London.
- Crownhart, C. 2023. [What's next for batteries](#). *MIT Technology Review*. Climate Change and Energy. Cambridge: Massachusetts Institute of Technology (MIT).
- Davies, H. and Pegg, D. 2023. [Serious Fraud Office drops 10-year corruption inquiry into Kazakh miner ENRC](#). Eurasian Natural Resources Corporation. *The Guardian*. London.
- De Brier, G. and Hoex, L. 2023. [Critical minerals and the need for equal partnerships with African producers](#). IPIS Briefing. Antwerp: International Peace Information Service (IPIS).
- De Decker, V. 2023. [The CRM Act in a global perspective](#). Egmont paper 121. Bruxelles: Egmont – Royal Institute for International Relations.
- De Melo, J. and Twum, A. 2021. [Prospects and Challenges for Supply Chain Trade under the Africa Continental Free Trade Area](#). Article. *Journal of African Trade*, 8(2 Special Issue): 49-61. Dordrecht: Atlantis Press. License CC BY-NC 4.0.
- Dempsey, H. 2023. [Artisanal mining: the struggle to clean up a murky industry](#). The Big Read, Rare earths. *Financial Times*. London.

- 
- Dempsey, H. and Campbell, P. 2023. [Rival battery technologies race to dominate electric car market](#). *Financial Times*. London.
- Dempsey, H. and White, E. 2023. [China's battery plant rush raises fears of global squeeze](#). Batteries. *Financial Times*. London.
- Desai, P. 2023. [Prices tumble for cobalt used for electric vehicle batteries](#). Charged. London: Reuters.
- Diene, P.D., Manley, D., Olan'g, S. and Scurfield, T. 2022. [Triple Win: How Mining Can Benefit Africa's Citizens, Their Environment and the Energy Transition](#). Report. New York, NY: Natural Resource Governance Institute (NRGI).
- Dinh, H.T. 2023. [Industrialization in Africa: Issues and Policies](#). Research Paper. Rabat: Policy Center for the New South.
- EC. 2022. [Questions and Answers: The European Battery Alliance: progress made and the way forward](#). Brussels: European Commission (EC).
- EC. 2023a. [Global Gateway: EU signs strategic partnerships on critical raw materials value chains with DRC and Zambia and advances cooperation with US and other key partners to develop the 'Lobito Corridor'](#). Press release. Brussels: European Commission (EC).
- EC. 2023b. [Proposal for a Regulation of the European Parliament and of the Council establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations \(EU\) 168/2013, \(EU\) 2018/858, 2018/1724 and \(EU\) 2019/1020](#). COM(2023) 160 final 2023/0079(COD). Brussels: European Commission (EC).
- EIU. 2023a. [The starting mark of a subsidy race](#). EIU report. London: Economist Intelligence Unit (EIU).
- EIU. 2023b. [China Going Global Investment Index 2023](#). EIU report. London: Economist Intelligence Unit (EIU).
- ElectricBee. N.a. [List of EV startups in Africa](#). Drongen.
- ETC. 2023. [Material and Resource Requirements for the Energy Transition](#). The Barriers to Clean Electrification Series. London: Energy Transitions Commission.
- Féligonde, A. de and Benoît, V. 2023. [Putting Africa at the heart of the global energy transition, thanks to its 'critical minerals'](#). Value chain. *the africa report*. Paris.
- Fernández, E. 2022. [Morocco: first 100% electric vehicle sets new milestone](#). New Technologies – Innovation. Madrid: Atalayar.
- Findeisen, F. 2023. [The Club Approach Towards Successful EU Critical Raw Materials Diplomacy](#). Policy brief. Berlin: Hertie School, Jacques Delors Centre.
- Foy, H. and Johnston, I. 2023. [The EU's plan to regain its competitive edge](#). The Big Read. EU Economy. *Financial Times*. London.
- García-Herrero, A. 2023. [Following a boom, China's electric vehicle industry now faces weak domestic demand and heightened geopolitical risk](#). Brussels: Bruegel.
- García-Herrero, A., Grabbe, H. and Källenius, Axel. 2023. [De-risking and decarbonising: a green tech partnership to reduce reliance on China](#). Policy brief. Brussels: Bruegel.
- Gericke, M., Nyanjowa, W. and Robertson, S. 2021. [Recycling of Li-ion batteries in South Africa](#). Pretoria: Waste Research Development and Innovation (RDI).
- GlobalData. 2023. [Do sodium-ion batteries have a future in the defence industry?](#) Analyst Comment. New York, NY: Army Technology.
- Goddard, E. 2022. [Dar es Salaam bags the lion's share of Copperbelt bulk freight](#). Africa, Sea freight. *Southern Africa's freight news*. Johannesburg: Freight News.
- Gong, H. and Hansen, T. 2023. [The rise of China's new energy vehicle lithium-ion battery industry: The coevolution of battery technological innovation systems and policies](#). *Environmental Innovation and Societal Transitions*, 46(100689). Copenhagen: The Department of Food and Resource Economics (IFRO) at the University of Copenhagen.
- Gordhan, P. 2023. [Battery storage system shows SA can get things done](#). Opinion. *BusinessDay*. Johannesburg: Business Live.

- 
- Hahn, T. and Auktor, G.V. 2018. [Industrial Policy in Morocco and its Potential Contribution to a New Social Contract](#). Discussion Paper 31/218. Bonn: German Institute of Development and Sustainability (IDOS) – ex DIE.
- Hajbi, M. 2023. [Morocco: Managem bets on cobalt](#). Blue Gold. *the africa report*. Paris.
- Herghelegiu, C. [The political economy of non-tariff measures](#). PSE working papers halshs-01385423, HAL. Ideas RePEc.
- Herzer Risi, L. and Doyle, C. 2023. [Examining China’s Impact on Mining in Africa: Critiques and Credible Responses](#). *Africa Up Close*, a blog of the Africa Program. Washington, DC: Wilson Center.
- Hidalgo, C., Klinger, B., Barabasi, A-L. and Hausmann, R. 2007. [The Product Space Conditions the Development of Nations](#). Science, 317(5837): 482-7. New York, NY: American Association for the Advancement of Science (AAAS).
- Hill, M. 2022. [The metals for your EV are stuck in a 30-mile traffic jam](#). London: Bloomberg.
- Hill, M. 2023a. [A New \\$850 Million Route to Speed Up Congo’s Copper Exports](#). Investing. Ontario: BNN Bloomberg.
- Hill, M. 2023b. [China’s grip on Africa’s minerals sparks a US response](#). Business, Bloomberg Originals. London: Bloomberg.
- Huang, S. 2023. [How the Inflation Reduction Act is a victory for U.S. EV Battery Manufacturers](#). Innovation. Forbes. Jersey City, NJ.
- IEA 2021. [The Role of Critical World Energy Outlook Special Report Minerals in Clean Energy Transitions](#). Wrold Energy Outlook Special Report. Paris: International Energy Agency (IEA).
- IEA. 2022a. [Africa Energy Outlook 2022](#). World Energy Outlook Special Report. Paris: International Energy Agency (IEA).
- IEA. 2022b. [Global Supply Chains of EV Batteries](#). Paris: International Energy Agency (IEA).
- IEA. 2022c. [In the transition to clean energy, critical minerals bring new challenges to energy security](#). Paris: International Energy Agency (IEA).
- Ilanakoon, I., Ghorbani, Y., Chong, M.N., Herath, G., Moyo, T. and Petersen, J. 2018. [E-waste in the international context - A review of trade flows, regulations, hazards, waste management strategies and technologies for value recovery](#). *IWWG, Waste Management*, 82: 258-275. Amsterdam: Elsevier, Science Direct.
- Interfax. 2023. [ERG seals five-year deal with EVELution Energy for cobalt supply to U.S](#). Moscow.
- IRENA. 2023. [Geopolitics of the Energy Transition](#). Abu Dhabi: International Renewable Energy Agency (IRENA).
- Islah, F. 2023. [Ryad Mezzour: Morocco is establishing genuine industrial sovereignty](#). Well-Rounded. *the africa report*. Paris.
- Jamasmie, C. 2018. [Congo miners buying cobalt from artisanal operators to balance market](#). Vancouver: Mining.com
- Jeong, H. and Allan, B. 2023. [Morocco’s position in the energy transition: A rising energy and EV supply chain power](#). Geopolitical brief 1. Baltimore, MD: Net Zero Industrial Policy Lab.
- Johnston, L. 2023. [China’s Africa strategy is shifting from extraction to investment – driven from the industry-rich Hunan region](#). Europe. *The Conversation*. Melbourne and Paris.
- Johnston, R. 2023. [Industrial Policy Nationalism: How worried should we be?](#) Energy Policy. New York, NY: Center on Global Energy policy at Columbia School of International and Public Affairs (SIPA).
- Joseph, A. 2023. [Africa is key source of critical minerals for the global energy transition – but there are hidden dangers](#). Opportunity Knocks OP-ED. *Daily Maverik*. Cape Town.
- Juhász, R., Lane, N., Oehlsen, E. and Pérez, V.C. 2023. [Trends in Global Industrial Policy](#). Vienna: UNIDO's Industrial Analytics Platform (IAP).
- Karkare, P. 2023. [Unpacking digital sovereignty through industrial policy](#). In Musoni, M., Karkare, P., Teevan, C. and Domingo, E. 2023. *Global approaches to digital sovereignty: Competing definitions and contrasting policy*, discussion paper 344, chapter 2: 19-33. Maastricht: ECDPM.
- Karkare, P. and Medinilla, A. 2023. [In search of shared benefits: Europe and Africa in a global green transition](#). ECDPM discussion paper 345. Maastricht: ECDPM.
- Kavanagh, M.J. 2023. [Congo Plans New Copper-Cobalt Smelter to Serve Informal Miners](#). London: Bloomberg.
- Kempen, T. 2023. [Sodium-Ion better than Lithium?](#) LinkedIn Article.

- 
- Khan, M., Kabir, S. and Ajefu, J. 2019. [Better jobs: A strategy to end fraud in skills training in Bangladesh](#). Working Paper 018. London: Anti-Corruption Evidence (ACE), SOAS Consortium.
- Kim, H. 2023. [Indonesia's uncertain climb up the nickel value chain](#). *the interpreter*. Sydney: Lowy Institute.
- Kitaw, M. 2023. [Making the Most of Africa's Strategic Green Minerals](#). Sustainability now. New York, NY: Project Syndicate.
- Klingebiel, S. 2023. [Geopolitics, the Global South and Development Policy](#). Policy Brief 14/2023. Bonn: German Institute of Development and Sustainability (IDOS).
- Kuhudzai, R.J. 2023a. [Kenya's President drives himself from State House in electric car to officially open Africa Climate Summit](#). Moorpark, CA: CleanTechnica.
- Kuhudzai, R.J. 2023b. [President of Kenya William Ruto inaugurates Roam Park — East Africa's largest Electric Motorcycle Assembly Plant](#). Moorpark, CA: CleanTechnica.
- Laing, T. and Pinto, A.N. 2023. [Artisanal and small-scale mining and the low-carbon transition: Challenges and opportunities](#). *Environmental Science & Policy*, 149(103563). Amsterdam: Elsevier, ScienceDirect.
- Lawal, T. 2023. [China beats Tesla to Nigeria's lithium riches](#). New York, NY: rest of the world.
- Lema, R., Fu, X. and Rabbellotti, R. 2021. [Green windows of opportunity: latecomer development in the age of transformation toward sustainability](#). *Industrial and Corporate Change*, 29(5): 1193-1209. Oxford: Oxford Academy.
- Lin, D. Bain, B. and Ahmad, J. 2023. [China in the driver's seat](#). 2-2-2. Arlington, VA: Special Competitive Studies Project (SCSP).
- Linnenkoper, K. 2022. [South Africa gears up battery recycling](#). Doetinchem: Recycling International.
- Lockett, W. 2022. [Sodium batteries are here and they will change everything](#). San Francisco, CA: Medium.
- Maihold, G. 2022. [A New Geopolitics of Supply Chains](#). *SWP*, Comment, 45. Berlin: German Institute of International and Security Affairs (Stiftung Wissenschaft und Politik, SWP).
- Mathieson, C. 2016. [The political economy of regional integration in Africa](#). ECDPM Report. Maastricht: ECDPM.
- Mavhunga, C.C. 2023. [Africa's move from raw material exports toward mineral value addition: Historical background and implications](#). MRS Bulletin. Springer Link. New York, NY: Springer Publishing.
- Mazzucato, M. 2021. [Financing the Green New Deal](#). *Nature Sustainability*, 5: 93-94.
- McKinsey and GBA. 2023. [Battery 2030: Resilient, sustainable, and circular](#). New York and Brussels: McKinsey and Company and Global Battery Alliance (GBA).
- McLeod, J. And Luke, D. 2022. [Breathing life into the AfCFTA: Why the details matter](#). Policy analysis. Winnipeg: International Institute for Sustainable Development (IISD).
- Mehdi, A. and Moerenhout, T. 2023. [The IRA and the US Battery Supply Chain: one Year On](#). Commentary, Critical Minerals. New York, NY: Center on Global Energy policy at Columbia School of International and Public Affairs (SIPA).
- Mengnan, J. 2023. [China ends electric vehicle subsidies](#). Transport. London and Beijing: China Dialogue.
- Millan, L. 2023. [When Will Africa Get Its First Gigantic Battery Factory?](#) Green, Cleaner Tech. London: Bloomberg.
- Money, D. 2023. [Zambia's copper fantasy](#). Shiny Dream. *the africa report*. Paris.
- Montmasson-Clair, G., Moshikaro, L. and Monaisa, L. 2021. [Opportunities to develop the Lithium-Ion Battery Value Chain in South Africa](#). Pretoria: Trade & Industrial Policy Strategies (TIPS).
- Moss, T. and Kincer, J. 2020. [New database release: RACE measures how unreliability drives true power costs](#). Blog. Washington, DC: Energy for Growth Hub.
- Mouanda-Mouanda, G. 2019. [Global Value Chains Participation for African Countries: An Overview from UIBE GVC Index System](#). *Open Journal of Business and Management*, 7:941- 962. Wuhan: Scientific Research Publishing.
- Müller, M. 2023. [The 'new geopolitics' of mineral supply chains: A window of opportunity for African countries](#). *South African Journal of International Affairs*, 30(2): 177-203. London: Taylor & Francis Group.



- 
- Müller, M., Saulich, C., Schöneich, S. and Schulze, M. 2023. [From Competition to a Sustainable Raw Materials Diplomacy](#). SWP, Research Paper. Berlin: German Institute of International and Security Affairs (Stiftung Wissenschaft und Politik, SWP).
- North Africa Post. 2023. [Automotive industry unseats phosphates again as Morocco's top exporting sector](#). Rabat.
- Olander, E. 2023. [Mapping the Chinese Cobalt Supply Chain in the DR Congo](#). *The China in Africa Podcast*. China Global South Project.
- Ongaji, P. 2023. [Here comes Kenya's first locally assembled electric bus](#). Nairobi: Nation Africa.
- Opalo, K. 2023b. [On America's structural inability to effectively compete with China in Africa](#). Blog. *An Africanist Perspective*.
- Opalo. 2023a. [Natural resources and economic \(under\)development in Africa](#). Blog. *An Africanist Perspective*.
- Pacot, E. 2023. [The Chinese conglomerate Tinci Group relocates its electrolyte production project from the Czech Republic to Morocco](#). Economy and Business. Madrid: Atalayar.
- Parkin, B. and Dempsey, H. 2023. [Miners' hunt for copper takes Barrick to Pakistan's western frontier](#). *Financial Times*. London.
- Parks, B.C., Malik, A.A., Escobar, B., Zhang, S., Fedorochko, R., Solomon, K., Wang, F., Vlasto, L., Walsh, K. and Goodman, S. 2023. [Belt and Road Reboot: Beijing's Bid to De-Risk Its Global Infrastructure Initiative](#). Policy Report. Williamsburg, VA: AidData at William & Mary.
- Pecquet, Julian. 2023. US launches investment network to engage private sector in Africa minerals strategy. Open Door. *the africa report*. Paris.
- Pettis, M. 2023. [How China's changing economy will impact the world](#). *The China in Africa Podcast*. China Global South Project.
- Pickles, S. 2023. [Value Addition in the Context of Mineral Processing](#). Study, e-paper. Berlin: Heinrich Böll Foundation, The Green Political Foundation.
- Pilling, D. 2021. [How Morocco transformed itself into a carmaking hub](#). Automobiles. *Financial Times*. London.
- Pilling, D. 2023. [Morocco's carmaking sector revs up for EV era](#). Morocco. *Financial Times*. London.
- Radley, B. 2023. [Disrupted Development in the Congo. The Fragile Foundations of the African Mining Consensus](#). Oxford: Oxford University press.
- Raji, R. 2021. [Electric Vehicles: Africa's battery minerals and GVC opportunities](#). News&Events, News. Singapore: Nanyang Technological University (NTU).
- Reuters. 2020. [ERG suspends Zambia refinery on shortage of cobalt, copper concentrates](#). Finance. London.
- Reuters. 2023a. [China curbs graphite exports in latest critical minerals squeeze](#). Commodities. London.
- Reuters. 2023b. [Namibia bans export of unprocessed critical minerals](#). Commodities. London.
- Reuters. 2023c.
- Reuters. 2023c. [US, Saudi Arabia in talks to secure metals in Africa, Wall Street Journal reports](#). Commodities. London.
- Revov, N.a. [2nd LiFe EV Batteries for Grid-Scale Energy Storage in South Africa](#). Johannesburg.
- Ritchie, H. 2021. [The price of batteries has declined by 97% in the last three decades](#). Oxford: Our World in data.
- Ritchie, H. 2023a. [Is cobalt the 'blood diamond of electric cars'? What can be done about it?](#) *Sustainability by Numbers*.
- Ritchie, H. 2023b. [Does the world have enough lithium to move to electric vehicles?](#) *Sustainability by Numbers*.
- Ritchie, H. 2023c. [Mining quantities for low-carbon energy is hundreds to thousands of times lower than mining for fossil fuels](#). *Sustainability by Numbers*.
- RMIS. Updated 2023. [Raw Material Profiles](#). Brussels: European Commission (EC).
- Saiidi, U. 2019. [We went inside Tesla's first Gigafactory](#). Video. International digital originals. Engelwood Cliffs, NJ: CNBC.
- Sanderson, H. 2023a. [Volt Rush-The Winners and Losers in the Race to Go Green](#). London: Oneworld Publications.

- 
- Sanderson, H. 2023b. [China's Dominance of the EV Battery Metal Supply Chain](#). *The China Global South Podcast*. China Global South Project.
- Schneidman, W. and Songwe, V. 2023. [Africa's Critical Minerals Could Power America's Green Energy Transition](#). Argument. Washington, DC: Foreign Policy (FP).
- Schoenberg, T. and Fernyhough, J. 2023. [Rio Tinto Settles US Bribery Case Linked to Simandou Mine](#). London: Bloomberg.
- Schröter, D. 2021. ["When we started, no one believed us": Bolivia's Electric Car](#). Lithium Worlds.
- Seccombe, A. 2019. [SA's Thakadu plunges into global nickel sulphate market](#). Companies, Mining. Johannesburg: Business Day (BD).
- Sedgman, P., Hong, J. and Lew, L. 2023. [China's Stranglehold on EV Supply Chain Will Be Tough to Break](#). Europe Edition. New York, NY: Bloomberg.
- Sguazzin, A. 2023. [Next Africa: Resource Nationalism or a Fair Share?](#) Newsletter. London: Bloomberg.
- Shaping Sustainable Supply Chains. 2022. [Is the electric age a game changer for South Africa's automotive industry?](#) Podcast #9.
- Shih, W.C. 2023. [The New Era of Industrial Policy Is Here](#). National Competitiveness. Boston: Harvard Business Review.
- Sichula, A. 2023. [FQM begins nickel concentrate production, set to become Africa's largest producer](#). Economy. Lusaka: Zambia Monitor.
- Siele, M.K.N. 2023. [Local investors are shying away from Africa's EV revolution](#). New York, NY: Semafor.
- Smith, N. 2023. [Where China is beating the world](#). *Noahopinion*, blog, 25 May 2023.
- Songwe, V. 2019. [Intra-African trade: A path to economic diversification and inclusion](#). In *Boosting trade and investment: A new agenda for regional and international engagement*. Research. Washington, DC: Brookings.
- Soulé, F. 2023. [What a U.S.-DRC-Zambia Electric Vehicle Batteries Deal reveals about the new U.S. approach toward Africa](#). Article. Washington, DC: Carnegie Endowment for International Peace.
- Stiglitz, J.E. 2017. [Industrial Policy, Learning, and Development](#). In Page, J. and Tarp, F. (eds), *The Practice of Industrial Policy: Government-Business Coordination in Africa and East Asia*, Chapter 2, 23-39. Oxford: Oxford Academic.
- Suarez, G. 2023. [GM is slowing EV production amid labor strikes and "evolving" demand](#). EV Still Buzzing. New York: Quartz.
- The Economist. 2023a. [Superbatteries will transform the performance of EVs](#). Science and technology, Electric cars. London.
- The Economist. 2023b. [China is winning Africa's "white-gold" rush for lithium](#). Middle East and Africa, Critical minerals. London.
- Thomas, D. 2023. [DRC and Zambia to establish SEZs for electric vehicle production](#). *African Business*. London.
- To, J. 2022. [The Eu-Ceap impacts on Developing Countries – Recommendations for development policy](#). Policy Brief 10/2022. Bonn: German Institute of Development and Sustainability (IDOS).
- Toll, M. 2023. [How Africa is set to blow past the rest of the world on electric motorcycles](#). Electric Motorcycles, Africa. Fremont, CA: Electrek.
- Toto, D. 2022. [Glencore, Managem partner to produce cobalt from recycled battery materials](#). News. *Recycling Today*. Richfield, OH.
- U.S. Dept. of State. 2022. [Memorandum of Understanding among the United States of America, the Democratic Republic of the Congo, and the Republic of Zambia concerning Support for the Development of a Value Chain in the Electric Vehicle Battery Sector](#). Washington, DC: U.S. Department of State.
- UNCTAD. 2023. [The Potential of Africa to Capture Technology-Intensive Global Supply Chains](#). Economic Development in Africa Report 2023. Geneva: United Nations Conference on trade and Development (UNCTAD).
- UNECA. 2021. [Facts&Figures: on cobalt, battery minerals and electric cars value chains](#). *Africa Business Forum 2021*. Addis Ababa: United Nations Economic Commission for Africa (UNECA).

- 
- Usman, Z. and Csanadi, A. 2023. [How Can African Countries Participate in U.S. Clean Energy Supply Chains?](#) Paper. Washington, DC: Carnegie Endowment for International Peace.
- Wang, C. and Allan, B. 2023. [China's overseas investments in critical minerals](#). Policy Brief 1. Baltimore: Net Zero Industrial Policy Lab.
- WB. 2023. [Democratic Republic of the Congo Country Economic Memorandum \(CEM\) - Pathways to Economic Diversification and Regional Trade Integration: Fostering Economic Diversification and Regional Integration for Faster Growth, Job Creation and Poverty Reduction](#). Washington, DC: World Bank. License: CC BY-NC 3.0 IGO.
- White House. 2023a. [FACT SHEET: Biden-Harris Administration Driving U.S. Battery Manufacturing and Good Paying Jobs](#). Briefing Room, Statements and Releases. Washington, DC: The White House.
- White House. 2023a. [Joint Statement from the United States and the European Union on Support for Angola, Zambia and the Democratic Republic of the Congo's commitment to Further Develop the Lobito Corridor and the U.S.-EU Launch of a Greenfield Rail Line Feasibility Study](#). Briefing Room, Statements and Releases. Washington, DC: The White House.
- White, E., Jung-a, S., Lewis, L. and Lin, A. 2023. [China set to overtake Japan as world's biggest car exporter](#). Automobiles. *Financial Times*. London.
- Whitehouse, D. 2023. [South Africa: Aqora plans Africa's first battery-cell gigafactory](#). Charging Up. *the africa report*. Paris.
- Yang, H. 2023. [LG Chem with China's Huayou to make battery materials in Indonesia, Morocco](#). Technology. London: Reuters.
- Yao, S. and Holden, J. 2021. [Chinese foreign mining investment — China's private sector eyes low-cost regions](#). New York, NY: S&P Global.
- Zang, P. 2023. [CATL, BYD's sodium-ion batteries both to be in mass production within this year, report says](#). Shanghai: CnEVPost.



## About ECDPM

ECDPM is an independent 'think and do tank' working on international cooperation and development policy in Europe and Africa.

Since 1986 our staff members provide research and analysis, advice and practical support to policymakers and practitioners across Europe and Africa – to make policies work for sustainable and inclusive global development.

Our main areas of work include:

- EU foreign and development policy
- Migration and mobility
- Digital economy and governance
- AU-EU relations
- Peace, security and resilience
- Democratic governance
- Economic recovery and transformation
- Climate change and green transition
- African economic integration
- Sustainable food systems

For more information please visit [www.ecdpm.org](http://www.ecdpm.org)

This publication benefits from the structural support by ECDPM's institutional partners: Austria, Belgium, Denmark, Estonia, Finland, Ireland, Luxembourg, The Netherlands and Sweden.

ISSN1571-7577