How China Came to Dominate the Global EV Lithium-ion Battery Value Chain

Lessons and Opportunities for Africa

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HOW CHINA CAME TO DOMINATE THE GLOBAL EV LITHIUM-ION BATTERY VALUE CHAIN - LESSONS AND OPPORTUNITIES FOR AFRICA

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The electrification of vehicles is accelerating and the global automotive industry is under full transformation. China has become an indispensable partner for EV makers as the only country that has succeeded in building a complete and competitive industry value chain of EV lithium-ion batteries. Top-down government-led policymaking has been an important driver; bottom-up firm-level vertical integration strategy and investments have effectively created a closed-loop supply chain. Africa is still at an early stage in this mobility transition. But with its rich deposits of minerals and potential markets, it can become a key player in the global EV value chain, if a favourable ecosystem for the fast uptake of EV and related green businesses could be developed in time.

1. China's fully-fledged industrial value chain for EV batteries

For the automotive industry, the Chinese market not only offers an opportunity for rapid growth, but is also driving alternative technologies for electric mobility (Proff, 2012). Along with Japan and South Korea, China is one of the top three producers of batteries used in EVs, drawing on its advantages in battery technology, which include the earth's largest reserves of rare earth metals and a solid manufacturing base (Wang and Kimble, 2011). The sales of EV lithium-ion battery in China have grown rapidly from 4.4 GWh in 2014 to 80 GWh in 2020. Now, more than 2/3 of the global total EV lithium-ion battery production capacity is located in China. A few leading Chinese battery firms have developed price advantage based on mass production and economy of scale. Meanwhile, battery technology and design keep evolving fast, requiring constant innovation and important R&D investment. Under strong market competition, we are observing an acceleration of industrial consolidation in China: the number of operative battery makers has reduced from about 240 in 2015 to about 50 in 2020; the Top 10 battery makers' combined market share has grown from 82.85% in 2018 to 92.44% in 2020 (see Table 1). With Europe and other foreign markets taking off with EV demand recently, Chinese battery firms are increasing battery export. Leading firms such as CATL, BYD, Gotion, Envision and Svolt are also building factories overseas to supply directly to local OEMs.

The **African Industrial Policy in the 21st Century (AIP21)** network brings together scholars to share research results and outline a new research agenda in view of developing new thinking for a green and resilient industrial policy in Africa for the 21st century. The AIP21 Network organized a series of workshops in 2022 on green industrialization in Africa at Copenhagen Business School and the University of Johannesburg in South Africa, with co-funding from DANIDA's Knowledge in Action grant. These policy briefs are some of the outputs from the workshops.

Table 1: Top 10 Chinese battery firms in terms of installed capacity

2020 Top 10	Installed (GWh)	2019 Top 10	Installed (GWh)	2018 Top 10	Installed (GWh)
CATL	31.48	CATL	32.31	CATL	23.52
BYD	9	BYD	10.78	BYD	11.44
LG Chem	6.54	Gotion Hi-tech	3.22	Gotion Hi-tech	3.09
CALB	3.77	Lishen	1.95	Lishen	2.07
Gotion Hi-tech	3.24	EVE Energy	1.84	Farasis	1.9
EVE Energy	1.02	CALB	1.49	BAK	1.74
Lishen	0.9	Farasis	1.21	EVE Energy	1.27
Farasis	0.87	CATL-SAIC	0.74	National power	0.82
Ruipu	0.64	BAK	0.69	CALB	0.72
Jeve	0.57	Sunwoda	0.65	CENAT	0.64
Total top 10	**58.03**	**Total top 10**	**54.88**	**Total top 10**	**47.21**
Total China	**62.85**	**Total China**	**62.38**	**Total China**	**56.98**
Top 10/China	**92.44%**	**Top 10/China**	**87.98%**	**Top 10/China**	**82.85%**

Source: Gao Gong Industry Institute (GGII), February 2021, January 2020, January 2019

2. China's comprehensive industrial policy under continuous adjustments for forging its EV value chain

The transition from Internal Combustion Engine (ICE) transport towards low- or zero-emission modes of transport cannot be left to technological roadmaps and market coordination alone. Instead, it depends on a more comprehensive policy to steer the electrification of the automotive industry on to a greener, more efficient and socially inclusive track (Pardi, 2021). In the case of China, government-led policymaking and constant adjustments have been one of the main drivers of the fast-growing EV industry and the lithium-ion battery sector(Wang, Zhao and Ruet, 2022). In 2009, Chinese government started to provide considerable subsidies, at both central and local levels, for NEV purchase. In practice, the NEV policy covers a range of aspects, but the most important are technical requirements, battery efficiency measurement, purchase tax exemption, and practical advantages such as priority registrations, unlimited city travel, free parking and discounted charging fee. From 2010 to now, NEV policies were significantly amended after their initial implementation (Chen, Midler and Ruet, 2018). Most importantly, there was a rapid tightening of technical requirements, enabling a better allocation of government subsidies, as the initial subsidies led to the use of short-range batteries and a proliferation of inefficient battery makers. Through the progressive reinforcement of technological requirements, the government has aimed to stimulate the intensification of R&D and technological densification in the Chinese automotive industry regarding the tripod of electric range + battery power + energy consumption (Muniz, Belzowski and Zhu, 2019).

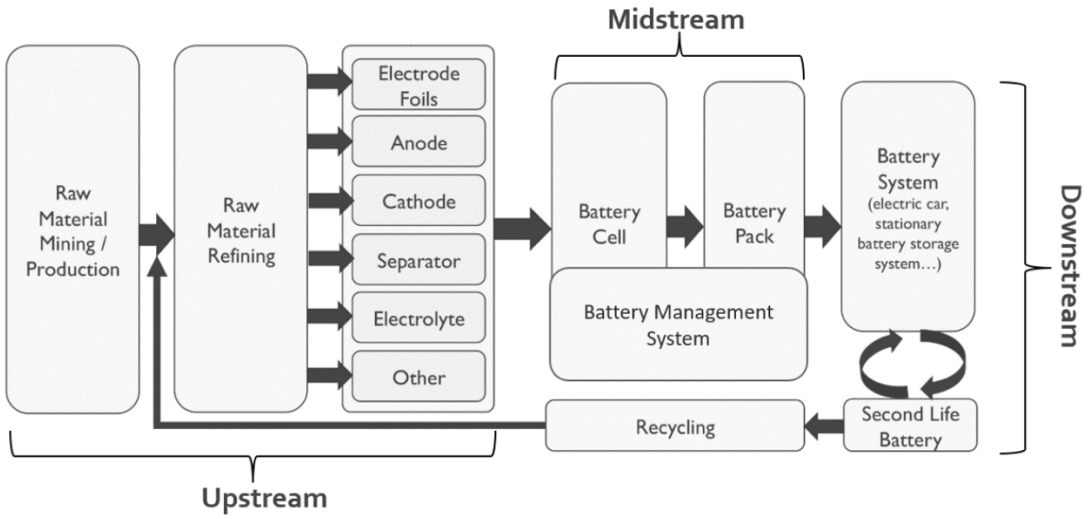
Infant industry protection policy was also temporarily adopted by the Chinese government to support the initial development of the battery sector. In 2016, to exclude foreign competitors and protect its nascent lithium-ion battery industry, the Ministry of Industry and Information Technology (MIIT), one of four central ministries orchestrating the NEV policy, introduced the catalogue of 'Regulations on the Standards of Automotive Power Battery Industry' – commonly known as the 'whitelist': only battery models fully owned by domestic battery makers were listed, and hence eligible for government NEV subsidies. This measure effectively chased Japanese and South Korean battery firms, such as South Korea's LG Chem and Samsung, out of the Chinese local market; some of them had to postpone their projects in China. The regulation gave Chinese firms a time window to build their own comparative advantages, through methods including technology absorption, economies of scale, supply chain lock-up effects, etc. As Chinese battery firms have become more competitive, the Chinese government has eased the protectionist measure, allowing foreign battery firms to regain market access to China.

Since 2016, China started to gradually phase out its direct EV subsidies; COVID-19 has brought large uncertainty to the market evolution and the Chinese government has decided to postpone the total cancellation to the end of 2022. Since 2018, China

started to substitute the direct subsidy with a market-based NEV programme combining an NEV credit (increasing each year) and trading system with the pre-existing fuel consumption requirements, known as CAFC. This way, the government will no longer bear the financial burden; instead, OEMs will have to invest in R&D to improve the fuel efficiency of their vehicles or buy credits from other OEMs to avoid penalties if the CAFC and/or NEV credit targets are not met. The opening up of the Chinese EV and battery market goes hand in hand with the shrinking of the subsidy. This exemplifies a typical Chinese style of industrial policy adaptation – switching from protecting the nascent industry to stimulating core technology innovation and inducing consolidation – aimed at producing strong local competitive advantage and national champions (Wang, Zhao and Ruet, 2022).

Moreover, China has strongly subsidized the development of charging stations by both public and private public operators. There were over 2.6 million charging stations in China by the end of 2021, and more are still coming. China is also actively promoting the recycling of end-of-life lithium-ion batteries. OEMs usually collaborate with their battery suppliers or specialised battery materials firms to recycle lithium-ion batteries. As prices of raw materials such as cobalt, nickel and lithium have seen rapid increase in 2022, battery recycle has become an attractive business for many actors, therefore there is urgent need to establish relative standards and regulations.

Figure 1: The value chain of lithium-ion battery manufacturing



Source: "Status of the Rechargeable lithium-ion battery Industry Report", by Rosina, M. (2017), with authors' adaptation.

3. Chinese battery firms' specialised vertical integration strategy to secure comparative advantage

China's EV and battery industrial policy and its continuous adaptations are not the only driver of local dynamics. Extensive empirical observations from the field show that firms' value-chain strategies can also help answer the question of why China is so far the only country to have formed a complete and dynamic value chain for EV batteries so quickly. The full value-chain structure of the lithium-ion battery industry is illustrated in Figure 1. The different segments can be grouped into upstream activities (raw material mining and production, raw material refining, battery material production), midstream activities (battery cell, battery module, battery pack, BMS production) and downstream activities (battery system production and installation, battery storage, battery second life, recycling, etc.).

Based on the analysis of the main moves made by actors along the battery value chain, many Chinese firms deploy a strategy that can be defined as 'specialised vertical integration', i.e., actively entering related upstream and/or downstream segments within the EV lithium-ion battery supply chain, while continuing to reinforce their existing

capacity using specific established assets in the original segment of the value chain, which serves as an expansion base (Wang, Zhao and Ruet, 2022). Except for a few firms in specific niche segments such as equipment and support parts, almost all firms in the lithium-ion battery sector grow their business through vertical integration. Upstream firms integrate forwards to downstream segments such as battery recycling and energy storage, while downstream firms integrate backwards to upstream segments such as materials or components. Mid-stream firms undertake both forward and backward vertical integration. For example, mining and refining firms Jinchuan and Huayou have carried out forward integration to develop downstream businesses in battery materials and battery cell manufacturing, as well as battery recycling; incumbent battery makers BYD, CATL and Sunwoda have done almost full value chain integration, investing both in upstream mining and battery material production, and downstream used-battery based recycling and energy storage applications. New entrants are active in various segments, with preferences for battery making and complete EV assembly. The vertical integration is realised by acquiring or creating new assets by means of mergers and acquisitions, strategic alliances, joint ventures, industrial co-operation and greenfield investment, etc. This specific approach of specialised vertical integration, which is typical of strategies rooted in the resource-based view of the firm, has given the Chinese EV lithium-ion battery sector a unique internal dynamism, helping to secure its competitive advantage in the global value chain.

Meanwhile, battery firms in China quickly deepened their capabilities in mass production and R&D of battery technologies and products. Driven by demand, a wide range of products is available on the market, and production capacity has continued to grow at pace. Strong linkages and interactions between users (EV cars), producers (EV batteries) and suppliers (EV components) have been created through the active development of mainstream firms, further strengthening the localisation of the EV battery value chain in China.

Whether the firms are growing or competing, their strategic moves are enacted mostly within the boundaries of the lithium-ion battery value chain. The field of specialisation is centred on battery-related technologies, and vertical integration and entry mainly concern the segments of the battery sector, from upstream to downstream. Even the more diversified downstream activities are all based on specialised battery production, service and EV technology. The framework of the Chinese lithium-ion battery value chain has become the guiding light for firms' strategic choices at every stage.

4. Africa facing both great challenge and opportunities

From 2015 to 2018, Africa received about 40% of the used vehicles exported from EU, Japan and the US; in most Sub-Saharan African countries, around 85% of all four-wheel vehicle sales are used vehicles (UNEP, 2020). Many African countries have no restrictions on the imports of used cars, which often are very unsafe and polluting. With the world's major auto markets targeting the phase-out of internal combustion engine (ICE) vehicles by 2035, Africa risks to become their dumping ground. Although the current electric vehicle (EV) market in Africa is still a niche market, there is increasing interest to incentivise the uptake of EVs. This is driven by the climate pressures and air pollution in big cities, but also by potentials for creating new green industries and more jobs, and for better utilizing the vast renewable energy available across the continent.

Within the global value chain, safeguarding the supply of lithium has become a priority for battery firms – hence the importance of strategic alliances and joint ventures among lithium exploration companies, battery suppliers and vehicle manufacturers (Jussani et al., 2017). With the soaring demand for minerals for batteries and EVs, Africa, with its rich deposits of lithium, copper, cobalt and other minerals, could become a key player in the global EV value chain. As an example, Democratic Republic of Congo (DRC), the world's largest raw cobalt supplier, has recently announced its ambition to build its own battery industry: a pilot plant producing cobalt precursors for battery cathode is to be operational by the end of 2023; a complete battery cell factory could be built by 2030 (Randall, 2022). DRC is in contact with possible

partners, including Bosch and some Chinese companies. The African Development Bank also signed a pledge to help DRC's plan.

A recent survey conducted by the Association for Electric Mobility and Development in Africa (AEMDA) identifies lack of ambitious policies, limited charging infrastructure, low consumer awareness of EV products and services, and taxation issues as key barriers of EV adoption (Mukeredzi, 2021). From China's experience in building a successful EV and lithium-ion battery industry, African governments and interested parties must work together to develop a favourable ecosystem for the fast uptake of EV and related green businesses. A good starting is to design a EV promoting regulatory framework and apply incentive policies. This could include ban on imports of used ICE vehicles, setting vehicle emission standards, specifying technical requirements on EV production, EV purchase tax exemption, reduced electricity tariffs for charging, and subsidies for building charging infrastructure. Practical advantages should also be considered to encourage individual adaptation of EV. As shown by the case of China, it is important to continue monitoring the market and making adaptations to the policies and regulations.

An adequate infrastructure is fundamental to the market acceptance of EVs. Consumers are often worried about the driving range of EVs. Building an adequate infrastructure for EVs includes improving the access, reliability and efficiency of electricity grid, constructing a sufficient number of public charging stations, increasing the use of renewable energy for charging, and developing battery swapping solution. Many African countries are developing mini grids to increase electricity supply in remote areas; using renewable energy such as solar, wind or biomass, they can charge electric two-wheelers where access to the central grid is limited. Taking advantage of EV battery to charge off the peak times, especially at night, can help ease the pressure on the grid. Concerted efforts are needed from public and private energy suppliers, utility operators, OEMs and assemblers, battery producers and renewable energy technology providers.

It is necessary to both attract MNEs and encourage native enterprises in order to build a local or regional EV industrial value chain. The success of China has shown that active participation and specialised vertical integration by firms along the lithium-ion battery value chain have contributed to strong local dynamics, forming an unparalleled comparative advantage. In the case of Africa, on one hand, MNEs can bring with them technology, industrial experience, capital, supplier networks and management skills. Their involvement can be of help to design a good EV strategy, apply relevant regulations, finance infrastructure development and train local suppliers. Local initiatives and start-ups, on the other hand, can best respond to the needs of local markets, offering tailored products and services. Regional alliances and collaboration on EV assembling and parts production are necessary in order to mitigate the limit of small market size of a single country. This is also the case for EV battery materials and battery cell production.

Different types of financing should be adopted according to the needs, including asset financing for EV fleet, business financing for EV importers and assemblers, project financing for charging infrastructure, infrastructure financing for electricity grid and mini grids (Conzade et al., 2022). Asset financing – investing and managing or leasing a fleet of EVs – is already seen in some countries, such as Kenya; but more countries still rely on informal way of financing such as borrowing from family and friends. As purchase power is relatively low in the region, innovative models of financing, including credit guarantee, crowdfunding, subscription and shared ownership, might help bridge the gap. While for project and infrastructure financing, climate issue related green bonds and carbon credits can be used to involve more global investors. As a principal of development, it is important to mobilize private financing and enhance financial inclusion through digital innovation.

Knowledge transfer and human capital development are equally important. For many new industries to be built in Africa, one of the biggest difficulties is finding qualified human capital, combining established industrial knowledge and a good understanding of local specificities. As local

market could vary a lot from one country to another, developing e-mobility and EV manufacturing will require a strong collaboration of foreign and local partners. By gradually increasing the proportion of local employment in EV projects invested by MNEs, it is possible to accelerate knowledge transfer and human capital training. Younger generations with foreign higher education background, working experiences and global networks are likely to be the backbone of Africa's green and sustainable growth. African countries could adopt talent recruiting plans to attract leading international experts in scientific research, innovation and entrepreneurship, by providing them prestigious title, high pay, substantial resources for research and start-up projects, assistance with housing and travel costs.

RECOMMENDATIONS

Governments *should seize the time window to promote local EV industry development by designing a comprehensive regulatory framework and applying incentive policies, learning from the successful practices from China and other countries. Public financing for charging infrastructure and grid efficiency improvement is fundamental.*

Government-led R&D programs *should be emphasized to accelerate technology catch up and innovation. Talent recruiting plans should be adopted to attract leading international experts and young entrepreneurs.*

Governments and related institutions *should also create good market, fiscal and operational conditions to attract technologically leading MNEs in the EV value chain, encourage local startups and develop competitive industrial clusters.*

MNEs and leading foreign firms in the EV and battery industry *have the chance to test new and sustainable way of production organisation, for example constructing an EV industrial park built upon the concept of circular economy.*

Industrial investment funds dedicated to firms along the EV value chain *is a useful tool to accelerate local EV industry development and should be actively supported by governments.*

Regional alliances and collaboration on EV assembling and parts production, EV battery materials and battery cell production*, are necessary in order to mitigate the limit of small market size of a single country. Public events with B2B meetings and networks such as industrial associations could help create opportunities of cooperation.*

Through organisation of international conferences bringing in industrial experts and academic researchers focused on EV industry to discuss current trends could accelerate knowledge spillover and invite new business ideas.

ABOUT THE AUTHOR

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