



Powering Resistance

Opportunities and Challenges in Localizing
Taiwan's Drone Battery Supply Chain

Jia-Shen Tsai, Angela Glowacki,
Chen-Yen Chang, and Yu-Ping Yang

July, 2026

Powering Resistance

**Opportunities and Challenges in Localizing
Taiwan's Drone Battery Supply Chain**

Research Institute for Democracy, Society and Emerging Technology (DSET)

Founded in October 2023 by Taiwan's National Science and Technology Council (NSTC), the Research Institute for Democracy, Society, and Emerging Technology (DSET) is Taiwan's first national think tank focused on the intersection of democracy, technology, and public policy. DSET places democratic values at the core of its mission and addresses emerging global challenges through evidence-based research and strategic analysis.

DSET's research focuses on four key areas: Economic Security, Democratic Governance, Energy Security and Climate Resilience, and National Security. It also operates a Non-Resident Fellow program that engages Taiwanese scholars and graduate students based in the United States, Europe, Japan, and other like-minded countries. Through policy research, international dialogue, and Track 1.5 diplomacy, DSET provides strategic recommendations to the public and government, strengthens Taiwan's global engagement, and promotes democratic, future-oriented approaches to technology governance.

About Energy Security and Climate Resilience Program of DSET

The Energy Security and Climate Resilience Program at DSET focuses on the intersection of energy security, climate risks, and strategic resilience in Taiwan. Its research explores critical issues, including Taiwan's energy security and resilience during the potential Taiwan Strait Crisis, Taiwan's strategic position in the clean-tech supply chain and multinational cooperation, the water and electricity use of Taiwan's semiconductor industry, China's climate diplomacy, etc. The program's insights have been featured in *Nikkei Asia*, *The Diplomat*, *Deutsche Welle*, *Australian Broadcasting Corporation*, *East Asia Forum*, and other international media and forums.

Report Disclaimer

This report was independently reviewed and published by DSET. The views expressed herein are solely those of the authors and do not represent the official position of the Government of Taiwan or the National Science and Technology Council (NSTC).

© Published in 2026 by the Research Institute for Democracy, Society, and Emerging Technology (DSET), Taiwan

Author

Jia-Shen Tsai | Non-Resident Research Fellow

Jia-Shen Tsai is a non-resident fellow at DSET, where his work examines the intersection of climate policy and national security. His research spans energy transition, transportation decarbonization, and carbon pricing, with a focus on designing low-carbon transformation pathways that strengthen national resilience without compromising public well-being. He holds a Master of Environmental Management in Environmental Policy and Economics from Duke University.

Angela Glowacki | Policy Analyst

Angela Glowacki is a policy analyst on the Energy Security and Climate Resilience Research Program at DSET. Her research focuses on critical mineral supply chains, next generation clean-tech and infrastructure, and energy-related maritime security.

Chen-Yen Chang | Policy Analyst

Chen-Yen Chang specializes in technology policy research related to climate change and weather forecasting. At DSET, he conducts reports on Taiwan's semiconductor industries, focusing on water and electricity supply, climate adaptation, and related challenges. His work also covers energy topics such as submarine power cables, energy stockpiles in the event of a Taiwan Strait Crisis, and international collaboration on emerging energy technologies, including perovskite solar cells and hydrogen energy.

Yu-Ping Yang | Research Assistant

Yu-Ping Yang is a master's student in International Relations at the Department of Political Science, National Taiwan University. She is also a research assistant with the Energy Security and Climate Resilience Research Program at DSET. Her research focuses on international disputes and geopolitical analysis, with particular interests in energy security and maritime policy.

Contributors

Tsaiying Lu | Director

Tsaiying Lu is a Research Fellow and Director of the Energy Security and Climate Resilience Program at DSET. Her team's work focuses on the intersection between energy, economics, and national security, including Taiwan's energy resilience during the potential Taiwan Strait Crisis, Taiwan's strategic position in the green-tech supply chain, an analysis of the water and electricity use of Taiwan's semiconductor industry, and China's overseas investment in critical minerals.

Cartus Bo-Xiang You | Deputy Director

Cartus Bo-Xiang You is the non-resident fellow and deputy director of the Energy Security and Climate Resilience Program at DSET. His research at DSET centers on the supply chain resilience of energy technologies and infrastructure, particularly energy security issues arising amid digital and sustainable transitions.

Acknowledgments

The Research Institute for Democracy, Society, and Emerging Technology (DSET) gratefully acknowledges the many individuals whose contributions made this report possible. The scope and rigor of this work depended on the expertise and generosity of our contributors at every stage of the research process.

We thank our interviewees from Taiwan's battery manufacturing and industry association community, alongside international counterparts from the battery materials sector, and international policy stakeholders. Their perspectives were instrumental in clarifying the current state of Taiwan's drone battery sector and deepening the report's analysis.

This report was a collaborative endeavor, and we extend particular appreciation to our reviewers, Tsai-Yuan Tsai, Ting-Kai Lu for their review, editorial input, and formatting assistance.

Table of Contents

Executive Summary

1. Introduction	01
2. Raw and Refined Battery Material Chokepoints	05
Specifications and Preferred Chemistries for Military-Grade Drone Batteries	06
Battery Components	08
Battery Supply Chain and Manufacturing Processes	09
Electrode Active Material	11
A Closer Look at China's Upstream Dominance in the Battery Cell Supply Chain	14
The Primary Driver Behind the Battery Cell Cost Gap	19
Conclusion	24

3. Taiwan's Battery Industry: Growing Capability With Material Vulnerability	25
Profile of Taiwan's Battery Industry	26
Small Scale, High Impact: The Strategic Edge of Taiwan's NMC Batteries in Ukraine	30
The Niche Market Constraint of Drone Battery	35
Taiwan's Lack of Local Up/Midstream Material Suppliers Presents Another Significant Challenge to De-Redding the Supply Chain	37
4. Policy Recommendations	39
Governance Framework for Non-Red Battery Supply Chains: Disclosure and Decoupling	41
Build Scale Through Standardization and Allied Export Markets	43
Secure non-Chinese CAM, pCAM, and AAM Supply	46

Concluding Remarks	48
Appendix 1 : List of Interviewees	51
Appendix 2 : Glossary of Relevant Terms	54
References	57

Executive Summary

Taiwan's drone supply chain is expanding rapidly. Drone exports in 2025 were nearly 35 times higher than in 2024, and exports in the first quarter of 2026 have already exceeded the full-year total for 2025. However, the batteries that power these drone systems remain one of the challenges for Taiwan's defense industry in its attempt to achieve a non-red supply chain.

Drawing on in-depth interviews with battery manufacturers and electrode material suppliers in Taiwan, Japan, and the United States, alongside industrial data analysis, this report compares policy approaches across countries to advance recommendations for how Taiwan can reduce its exposure to China in the production of lithium batteries for drones. The research indicates that although the share of Taiwan-made drones using Chinese cells has fallen from 70 percent to 50 percent and Taiwan now possesses internationally competitive downstream packing capacity, the upstream supply risk persists. Sectors such as cathode active materials (CAM), CAM precursors (pCAM), anode active materials (AAM), and battery-grade refined minerals remain heavily dominated by China. Furthermore, China has shown a tendency to strategically control the export of high-energy-density lithium battery-related materials and technologies over the past three years.

To avoid the risks posed by China in the battery supply chain, a sufficiently large and high-specification market demand for non-China-made batteries is needed to incentivize electrode material manufacturers to invest in producing key raw materials that cost more than 40-50% more than those manufactured in China. However, due to the highly fragmented demand for drone batteries and the market size being far smaller than that of electric vehicles or large-scale energy storage systems, market mechanisms alone are insufficient to drive Taiwanese manufacturers to invest in production lines, nor are they enough to attract material suppliers from outside China to set up factories in Taiwan.

To solve this problem, it is not enough to simply rely on existing regulations, such as excluding non-China-made batteries from public sector drone procurement. Taiwan must adopt an integrated industrial strategy,

connecting defense and public sector drone batteries with the broader demand for high-end batteries, and playing the role of a "procurement partner" within that alliance framework, actively participating in the standards setting agenda. By aggregating demand and guiding non-China-made battery-grade material suppliers to invest in long-term production, Taiwan and its strategic partners can jointly reduce their dependence on China in the drone battery supply chain.

1. The Structural Risk of the Battery Supply Chain Lies in the Reliance on Chinese-made Cathode and Anode Active Materials

The high energy density and fast discharge speed of the NMC chemistry makes it a primary choice for drone applications. However, China controls roughly 65 percent of global NMC CAM production, 95 percent of pCAM, 97 percent of AAM output, and 95 percent of battery-grade graphite processing. In 2025, Beijing imposed export restrictions on cathode technologies, placed battery cells and precursors on the Dual-Use Export Control List, and sanctioned eight Taiwanese defense-linked enterprises. These actions clearly demonstrate how China has leveraged its upstream monopoly to pursue its geopolitical interests.

2. Taiwan's drone battery industry possesses both international technological achievements and structural exposure

Taiwan has considerable downstream technological capabilities. According to this report, Taiwan's annual battery cell production capacity is approximately 9.41 GWh, and it holds a dominant position in battery pack packaging.

Interview data shows that at least one Taiwanese manufacturer maintains monthly shipments of 5 to 7 million cells to Ukraine. According to Ukrainian customs data (HS 8507 electric storage batteries), Taiwan's battery exports to Ukraine in the first quarter of

2026 amounted to approximately \$US11.85 million. Looking at historical figures, Taiwan has risen from 24th place among Ukrainian suppliers in 2019 to 3rd place in 2025, second only to China and Vietnam.

However, this report points out that Taiwan's battery industry is still constrained by three structural conditions:

- **Inconsistent battery chemistry with military-grade requirements:** Approximately half of Taiwan's domestic battery cells are lithium iron phosphate (LFP), whose characteristics do not meet military-grade requirements, and less than half of the battery modules used in drones are non-red batteries.
- **High exposure to upstream supply chains:** Currently, Taiwan has no domestic manufacturers of high-nickel cathode active material or cathode precursors.
- **Insufficient market scale benefits:** Taiwan's drone battery cell market is too small and fragmented to attract upstream material investors.

Policy Recommendations

1. Sharpen non-red battery supply-chain governance in line with international traceability timelines

In January 2026, the Public Construction Commission under the Executive Yuan issued a drone procurement guideline encouraging agencies at all levels to incorporate non-red sourcing requirements into their tender documents. Under the guideline, the procurement of drone battery modules and other passive components must be sourced from non-Chinese suppliers from 2027 onward.

Drawing on industry interviews and a review of the EU Battery Regulation, the EU Critical Raw Materials Act (CRMA), and the procurement restrictions on Foreign Entities of Concern (FEOC) scheduled under the 2026 U.S. National Defense Authorization Act (NDAA), this report recommends that the government set a clear timeline for removing Chinese inputs at the cell and material level. By 2028, publicly procured drones should use Taiwan-made battery cells and non-Chinese material suppliers.

Phasing in this adjustment would strengthen firms' incentive to diversify their upstream sources and build a workable basis for origin tracing. It would also position Taiwanese manufacturers to qualify for the U.S. Department of War procurement list and prepare them in advance for the EU battery-market requirements now coming into force.

2. Build scale through standardization and high-spec aligned export markets

Taiwan should address the challenges of highly atomized demand and insufficient market scale in its drone battery sector by driving specification standardization and expanding exports. Specifically, Taiwan should target Eastern Europe and the Ukrainian market, leveraging battlefield deployments to establish technical credibility, accumulate operational data, and aggregate order volumes necessary to surpass the minimum order quantity (MOQ) thresholds enforced by upstream material suppliers.

In addition to customized designs, Taiwan should strategically plan the mass production of standardized cells built on common military specifications. Concurrently, the government should provide targeted subsidies for verification and testing costs, thereby assisting small and medium-sized manufacturers in acquiring the credentials required to enter high-value allied defense markets and adjacent emerging sectors such as eVTOL aircraft and robotics, effectively expanding the scale of market demand.

3. Secure non-Chinese cathode and precursor supply

Taiwan should address the structural gap in upstream cathode and anode materials by combining short-term stockpiling – viable for roughly six months – with longer term strategies to build non-Chinese material flow, since domestic CAM and pCAM production from scratch is economically unrealistic given thin midstream margins. We recommend pursue three complementary paths: attract non-Chinese CAM and pCAM manufacturers to build facilities in Taiwan through direct government incentives, engage actively as an advisor in the Partnership for Indo-Pacific Industrial Resilience (PIPIR) dialogue and propose the aggregation of demand across allied partners; and develop a recycled-feedstock pathway by coordinating domestic recyclers and cell manufacturers to secure offtake agreements with midstream partners.

Scope of Report

Chapter one situates Taiwan's drone procurement expansion against its persistent reliance on Chinese-made batteries, a supply chain Beijing has already shown inclination to weaponize through export controls and targeted sanctions on defense-linked firms.

Chapter two maps the global lithium-ion battery supply chain from raw mineral extraction through midstream processing of cathode and anode active materials to cell manufacturing, identifying NMC cells and its upstream as the strategic chokepoint.

Chapter three assesses Taiwan's battery industrial position, the three structural constraints on drone-battery security (chemistry mismatch, upstream dependence, insufficient scale), and elucidating that current policy push does not address supply chain disruption risk while market pull remains inadequate.

Chapter Four sets out concrete policy recommendations organized around three mutually reinforcing strategic actions: extending procurement rules to electrode materials, building economies of scale by driving specification standardization and integrating international market demand, and seeking strategic cooperation with non-Chinese upstream material suppliers.

Chapter 1

Introduction

Taiwan is scaling its uncrewed systems at a historic pace. The Ministry of National Defense plans to procure roughly 50,000 drones by 2027, and in January 2026 it presented a special defense budget that would fund the acquisition of over 200,000 additional unmanned aerial vehicles (UAVs) across multiple mission categories.^{1,2,3} The Ministry of Economic Affairs projected that Taiwan's monthly drone production capacity will grow from its current 15,000 units to 100,000 units, with drone exports expected to increase from 20% to over 50% by 2030.⁴ These figures signal a long-term commitment to distributed and attritable defense concepts.

Domestic defense demand alone cannot sustain a competitive drone industry; therefore, Taiwan's drone makers have looked to international markets.⁵ Drone exports surged nearly 35-fold year-on-year in 2025, with the Czech Republic alone accounting for over half the total and Europe — mostly transshipment to Ukraine — emerging as the dominant destination.⁶ Such an export-oriented push is not only true for Taiwan's drone manufacturers but also for critical components as batteries.

Based on Ukraine's State Customs Service data, under HS code 8507 (electric storage batteries), Taiwan rose from rank 24 in Ukraine's import in 2019 to rank 3 by import value in 2025, behind only China and Vietnam, with the second-highest unit value of any supplier after the United States (See Ch.3). Taiwanese cells are competitive precisely on the dimension that matters in a battlefield drone: high energy density (normally over 300 Wh/kg) at low temperature.⁷

Although Taiwan's drone exports are growing, the cost gap between Taiwanese-made and Chinese-made cells continues to keep Chinese suppliers central to the supply chain. Industry interviews suggest that the selling price of Chinese cells is approximately 3-4 times cheaper than Taiwanese cells, which helps explain why approximately 50 percent of cells used in Taiwanese-made drones in 2025 still came from Chinese suppliers.^{8,9,10} Taiwan retains the technical capability to manufacture

battery cells and to assemble modules and packs, and plans to expand domestic production capacity to approximately 12 gigawatt-hours (GWh) by 2027.¹¹ Reliance on Chinese batteries has fallen over the past two years, with much of the displaced volume now sourced from South Korean suppliers, but the majority of drone manufacturers continue to favor Chinese cells because the markets they currently serve still prioritize cost.¹²

Taiwan's response to the overall exposure to Chinese-made components has so far been organized around the Drone National Team initiative, launched in 2022, and its incorporation into the National Development Council's 2024 "Five Trusted Industry Sectors Promotion Plan," which placed the drone industry under the defense-industry category.¹³ The Ministry of Economic Affairs' March 2026 Dual-Use Unmanned Aerial Vehicle Capability Development Program operationalizes this framework by subsidizing Taiwanese manufacturers' R&D in five priority modules: flight control, communication, navigation, artificial intelligence, and payload. However, cells, battery modules, and the cathode active materials (CAM) and anode active materials (AAM) that determine their performance are not on that priority list. This report highlights that a continued reliance on China-sourced battery cells and materials may be a critical vulnerability for Taiwan's drone supply chain.

In the past few years, the world has witnessed Beijing's growing inclination to weaponize its supply chains through export controls and selective enforcement for security reasons. In July 2025, Chinese Ministry of Commerce (MOFCOM) amended China's Catalogue of Technologies Subject to Export Prohibitions and Restrictions to impose immediate restrictions on cathode material processing technologies.¹⁴ In October 2025, MOFCOM and China's General Administration of Customs went further, placing high-energy-density lithium-ion battery cells, cathode material precursors, graphite anode materials, and their equipment on the

Dual-Use Items Export Control List. MOFCOM also added US drone manufacturers and Taiwanese defense-linked firms to its Unreliable Entity List in 2025, effectively cutting off Chinese-made battery supply to these firms, on the stated grounds that they had endangered China's national interests.¹⁵ Taken together, these measures show that Beijing is prepared to use battery-related dominance as instruments of political and economic pressure.

Responses to these signals across allied defense ecosystems vary in their reach. The United States has codified the concern most directly. Section 842 of the FY 2026 NDAA closes the gap in the Defense Innovation Unit's Blue UAS Framework, prohibiting the DoW from procuring advanced batteries—including cells and key components—owned, sourced, refined, or produced by a foreign entities of concern (FEOC).^{16,17} Ukraine has built its 2026 "China-free drone" procurement strategy around the same imperative.¹⁸ Japan and the European Union have advanced parallel concerns through broader battery and critical-minerals frameworks though without drone-specific provisions to date.^{19,20} For Taiwanese battery manufacturers, compliance with these requirements increasingly determines access to the overseas markets, but the cost to find alternative sources for those materials required is substantially high.

How can Taiwan guide its battery industry toward non-Chinese materials to better address the supply chain risk? This report provides analysis and policy recommendations with the following chapters. **Chapter 2** maps the global lithium-ion battery supply chain from raw mineral extraction through midstream processing to cell manufacturing, identifying where value creation and vulnerability concentrate. **Chapter 3** assesses Taiwan's current battery industrial position and the policy gap between drone procurement and battery industrial strategy. **Chapter 4** sets out policy recommendations for Taiwan, organized around three mutually reinforcing actions: standards and governance for defense procurement, demand-side scale within the industry and with allies, and proactive engagement with prospective upstream suppliers.

Chapter 2

Raw and Refined Battery Material Chokepoints

The battery market as a whole encompasses technologies tailored to a massive range of end use applications. Military-grade drone batteries require distinct specifications that differ from EVs or even commercial-use drones. These drones, for example, must operate in extreme temperatures, rapidly deploy under heavy loads, and engage in extended flight times. The related specifications are embedded in the batteries and the materials they use, making access to them critical in the broader drone supply chain.

Specifications and Preferred Chemistries for Military-Grade Drone Batteries

Given the cost-restraint and rapid iteration scenarios of drone systems in the Ukrainian battlefield, this report focuses on Lithium-ion (Li-ion) batteries with the Nickel-Manganese-Cobalt (NMC) chemistry, which offer high energy density at scalable manufacturing cost.

Li-ion and lithium-polymer (LiPo) batteries are the two major power sources in drone applications. Lithium-polymer (LiPo) cells, with their tightly packable pouch-shaped format, dominate racing FPV-drone and small commercial systems due to their lighter and more flexible form factor.²¹ Pouch LiPo batteries thus hold a distinct advantage in the high-spec drone market, where they deliver the superior performance required for advanced operational demands. Li-ion cells, by contrast, utilize a liquid electrolyte housed within a rigid metal casing, typically in standardized cylindrical or prismatic formats, which makes them highly durable and cost-effective for mass production. The form factor supports^{22,23} modularization and interoperability within standardized defense supply chains, enabling more efficient integration across multiple drone systems.

Our interviews find that NMC production lines—shared with niche EV and power tool applications—give Taiwanese battery manufacturers a manufacturing base and technical track record from which to build market share in Ukraine. Though with poorer thermal stability and higher price, NMC delivers the balance of energy density, cycle life, and continuous-

discharge capability that long-endurance missions require. High-end military-grade drones require an energy density of approximately 300 Wh/kg to complete extended missions, well above the 90 to 160 Wh/kg range of typical lithium iron-phosphate (LFP) cells, the dominating chemistry in Chinese-made EV that are 30 percent cheaper than NMC cells.^{24,25,26}

This chapter offers a brief overview of the relevant battery types, specifications, and chemistries typically required for military grade drone usage. It also identifies significant levers that create chokepoints in the supply chain.

Battery Components

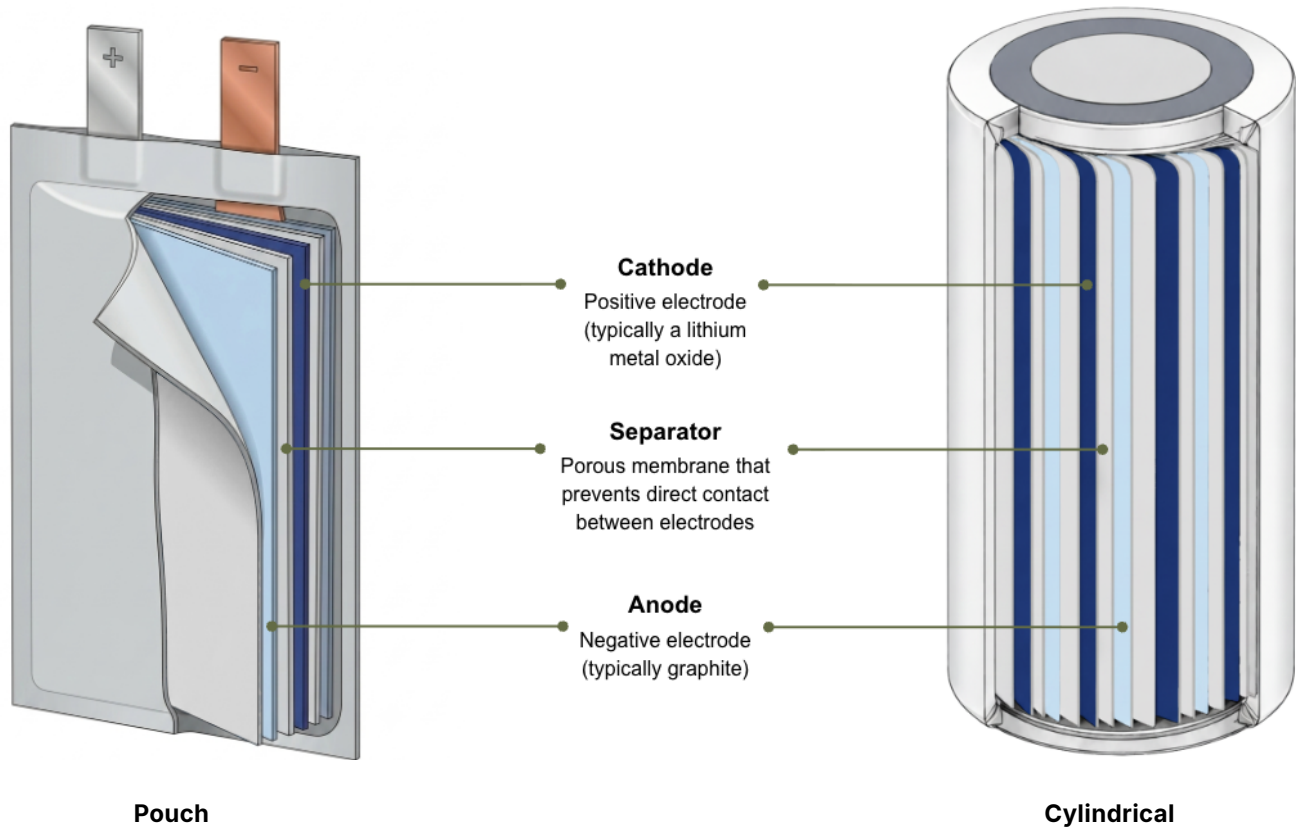
There are four main components in a battery cell: anode, cathode, electrolyte, and separator. Their functions and common materials are detailed in Table 1. During battery discharge, lithium ions travel through the electrolyte from the anode toward the cathode, triggering electrochemical reactions that release energy.

Among these components, the cathode and anode are the most consequential in both enabling the technical specifications of the battery's performance and presenting the biggest chokepoints in the supply chain due to the limited access to essential active materials. While electrodes also contain auxiliary components such as binders, conductive additives, and metal-foil current conductors, the active material is the core technological and industrial focal point and will be discussed further in the next section.

Table 1:
Battery Components

Component	Function	Common Material
Anode	Negative electrode. Acts as a storage for lithium ions when the battery is fully charged. ²⁷	Graphite, silicon, lithium
Cathode	Positive electrode. Receives the lithium ions traveling through the battery when discharging. ^{28,29}	Metal oxides (e.g. NMC, NCA)
Electrolyte	Liquid or gel substance that fills the space between electrodes. Acts as a conductive medium allowing lithium ions to move from one side to the other. ³⁰	Lithium salt
Separator	Thin, porous film placed directly between electrodes. Prevents anode and cathode from touching, avoiding thermal runaway (fire).	Polyolefins, ceramic coating

Figure 1: Battery Anatomy

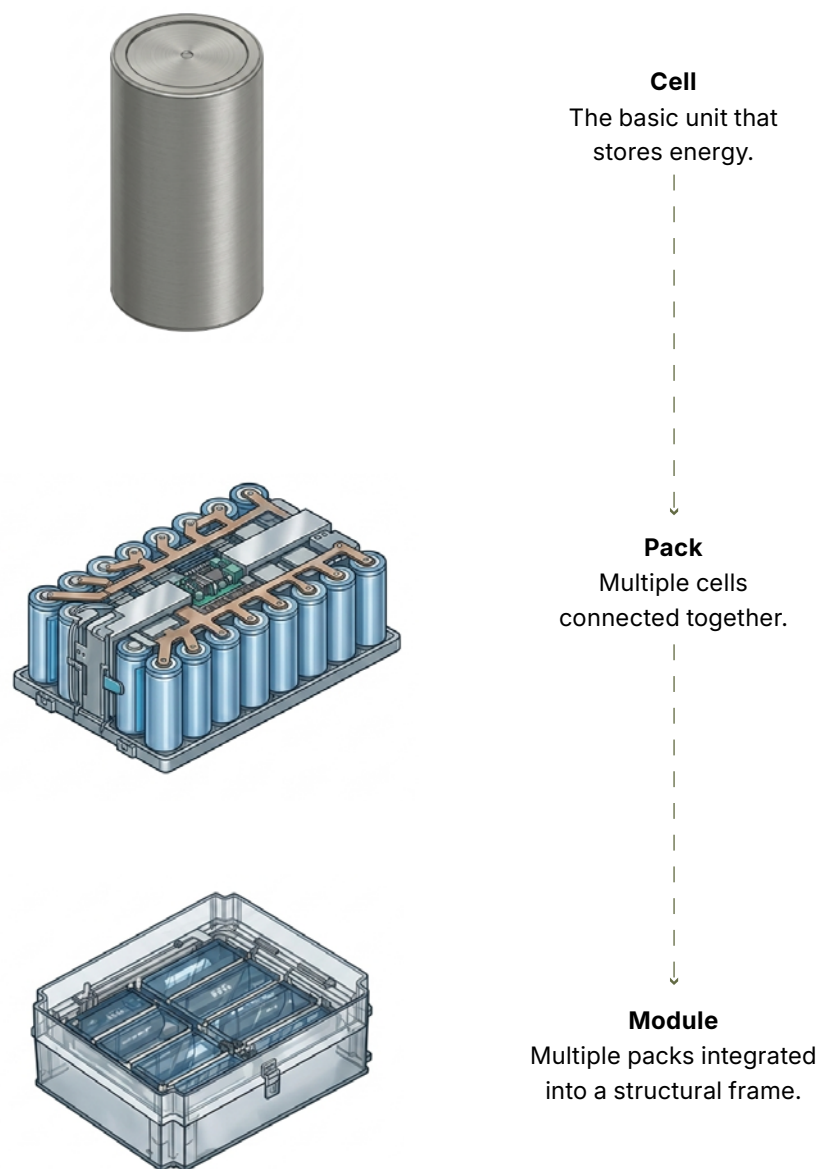


Battery Supply Chain and Manufacturing Processes

The battery supply chain is organized into five primary stages: raw mineral mining and refining, battery-grade chemical processing, electrode active materials, cells, and modules and packs. Upstream, critical minerals such as lithium, nickel, cobalt, and graphite are extracted from ore and refined into battery-grade chemicals like lithium hydroxide, nickel sulfate, and spherical graphite. These chemicals are then synthesized into CAM and AAM and coated onto conductive metal foils to form the electrodes. The electrodes are precisely layered (in pouch cells) or wound (in cylindrical cells) with separators between them, filled with electrolyte, and sealed to produce the finished cell, the fundamental electrochemical unit of energy storage. Individual cells are then clustered into modules for structural and thermal protection, and the modules are integrated into a battery pack equipped with a Battery Management System (BMS) to deliver power to the end application.

Although the downstream engineering of modules and packs is important for ensuring integration and thermal safety, the battery system's ultimate energy density, performance and cost structure are largely determined by the chemical composition established during the refining of raw materials and the manufacturing of electrodes. This process also represents the most critical economic and geopolitical chokepoints.

Figure 2: Battery Supply Chain



Electrode Active Material

CAM and AAM are the specific compounds found within each respective electrode that facilitate the storage and release of the battery's energy. Each containing unique characteristics, CAMs and AAMs are manufactured and sourced separately before being formulated into a slurry to coat the electrode that will go in the final cell.

Cathode Active Material

CAMs store and release lithium ions during cycling and are the biggest determinant of battery specifications and final cost of the cell. The CAMs are responsible for determining a battery's capacity, voltage, and power output. They also affect energy density via unique chemical compositions that are tailored for different applications. In general, there are seven main types of CAMs that are commonly used in drone batteries at present: LFP, LMO, LCO, NMC, NCA, LMR, and LMFP.^{31,32}

Table 2: Battery Chemical Materials

(Source: [Faraday Institution 2023](#))

Material formula	Abbreviation	Cost	Energy density	Thermal stability	Cycle life
LiCoO ₂	LCO	High	Moderate	Poor	Good
LiFePO ₄	LFP	Low	Low	Good	Good
LiMn ₂ O ₄	LMO	Low	Moderate	Good	Poor
LiNi _{0.6} Mn _{0.2} Co _{0.2} O ₂	NMC622	High	High	Moderate	Good

$\text{LiNi}_{0.8}\text{Mn}_{0.1}\text{Co}_{0.1}\text{O}_2$	NMC811	High	High	Poor	Moderate
$\text{LiNi}_{0.8}\text{Mn}_{0.15}\text{Al}_{0.05}\text{O}_2$	NCA	High	High	Poor	Moderate
$\text{Li}_{1.2}\text{Ni}_{0.13}\text{Mn}_{0.54}\text{Co}_{0.13}\text{O}_2$	LMR-NMC	Moderate	High	Moderate	Poor
$\text{LiMn}_x\text{Fe}_y\text{PO}_4$	LMFP	Low	Moderate	Good	Good

Among NMC Li-ion cells that dominate Ukrainian battlefield deployments, discharge profile, captured by the C-rate, distinguishes which packs serve which drone roles.³³ FPV drones generally need high discharge currents because their flight profiles depend on rapid throttle response and aggressive maneuvering. Competition racing packs sit at the extreme of this requirement, rated up to 150C continuous for the few minutes of peak-acceleration flight that competition demands.³⁴ Battlefield FPV operations flip the priority. Many missions require flight times of 30 minutes or longer, which pushes Ukrainian operators toward Li-ion packs operating at much lower C-rates — around 10C — where capacity and cycle life win over peak discharge.³⁵ A Ukrainian-assembled 6S2P pack built with Taiwanese-made cells, for instance, is roughly at 11C.³⁶ Across these drone roles, the discharge envelope remains different from EV battery requirements (around 3C), even though drone packs are built from the same cylindrical manufacturing base.³⁷

In the NMC chemistry, each mineral component serves a specific purpose: nickel increases energy density, manganese provides structural stability and prevents overheating, and cobalt sustains cycle life to ensure the battery can be frequently recharged. The proportions of each component

can be adjusted depending on the needs of the end user.³⁸ In many cases, particularly in defense technology, the exact ratio and processing of these chemistries are confidential to protect a manufacturer's technical edge and therefore its competitive advantage.

NMC chemistries have evolved over the years as higher nickel content has been introduced to increase energy density. The different generations of NMC are denoted by numerical ratios: (532), (622), (811), and (9.5.5). These numbers represent the molar ratio of each metal, for example NMC 532 contains 50% nickel, 30% manganese, and 20% cobalt. High nickel content correlates with higher energy density, but increasing its share is a chemically advanced process and most production is concentrated around the NMC 811 and 622 levels, especially for EV and drone applications.^{39,40,41} Higher-nickel chemistries (NMC 811 and above) in particular are used in military-grade drones, favored for their top energy density.^{42,43}

Anode Active Material

The AAM is critical for storing lithium ions and conducting electrons during charging, to later release during discharging. The capacity of the AAM determines how much energy the battery can store, facilitating higher energy density.⁴⁴ In addition, it also sets the lower voltage limit of the cell which in turn allows more energy to be delivered.⁴⁵ The AAM also determines the longevity of a battery, charging speed, and safety.⁴⁶

Common AAMs are graphite-based. Both natural and synthetic graphite are widely used, with silicon increasingly blended in to push energy density higher. Emerging materials such as lithium titanate and tin-based alloys are also being experimented with but are not yet prevalent on a commercial scale.⁴⁷ Our attention to graphite over silicon is informed by estimations that it is still the dominant material used in anodes, accounting for 98% of the global anode market and is expected to grow.^{48,49}

Natural versus synthetic graphite

Natural graphite has a diverse structure that allows it to store more ions and conduct energy more effectively, making it favorable for batteries that require higher energy density.⁵⁰ However, the varied structure makes it more likely to result in inconsistent performance, as well as shorter electrode life.⁵¹

Synthetic graphite, on the other hand, possesses a uniform carbon structure which allows for more consistent battery performance. Although synthetic graphite is favored due to its performance and durability, it is more expensive to produce high quality synthetic graphite due to the intensive manufacturing process. Producing the material involves heating the precursors to high temperatures for a week-long period, incurring high production costs and potential pollution.⁵² Consequently, production has historically been concentrated in regions with cheap energy, industrial clusters, and a willingness to accommodate these trade-offs, most notably China, creating a significant strategic chokepoint for the global Li-ion battery supply chain.

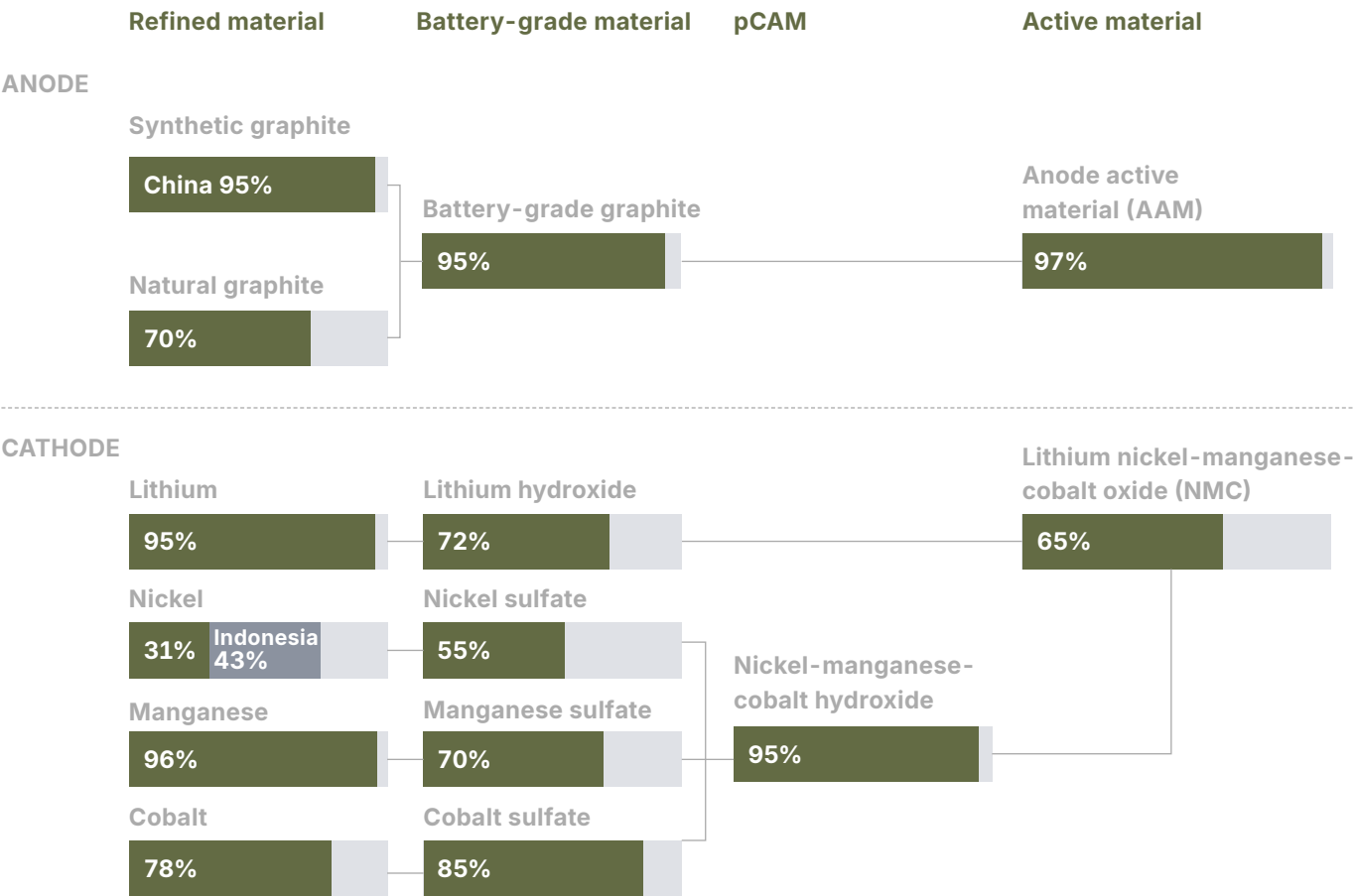
A Closer Look at China's Upstream Dominance in the Battery Cell Supply Chain

China's dominance in NMC cathode manufacturing is evident across every major processing stage, from refined materials to precursor cathode active materials (pCAM) and CAM. In 2024, China accounted for approximately 65 percent of the global NMC CAM production, compared to 28 percent for South Korea and 6 percent for Japan.⁵³ The concentration is even more pronounced at the pCAM stage, where China's share of production reaches 95 percent.⁵⁴

Upstream refining capacity reinforces this dominance. China controls an estimated 31 percent of global nickel refining, 79 percent of cobalt refining, and 96 percent of manganese refining. It is key to note that Indonesia holds an additional 43 percent of nickel refining, but much of the market is controlled by Chinese firms.⁵⁵ These shares create structural dependencies that flow into downstream cathode production.

China's dominance over AAM production is also extreme, commanding 97 percent of global anode production.⁵⁶ Its massive share is evident across several key inputs in the upstream supply chain: 70 percent of the world's natural graphite, 95 percent of synthetic graphite production, and 95 percent of battery-grade graphite processing are all found in China.⁵⁷

Figure 3: China's share of global battery material processing, by supply chain stage
(Data from sources ^{58,59,60,61,62,63,64,65})



China's critical minerals strategy extended beyond just domestic manufacturing dominance. Actually, China has limited domestic reserves for battery metals such as lithium, cobalt, or nickel. For example, only around 1.3% of the world's mined cobalt is found physically within China's territories, yet China controls around 73 to 78% of the world's refined cobalt.⁶⁶ This is due to its mining equity in other resource-rich countries and massive investments in overseas refining facilities. China's Belt and Road Initiative has also paved the way for Chinese companies to dominate critical mineral flows overseas, as recipient countries have traded mineral concessions for the construction of much needed infrastructure such as roads, railways, and ports.⁶⁷ Additionally, generous state-backed financing has allowed Chinese firms to maximize their leverage in African mines as firms acquired minority stakes then gradually took over the boards to obtain majority stakes. Through this strategy, along with joint ventures and acquisition arrangements, many projects became entirely Chinese-owned, with the some exceptions of larger projects.⁶⁸ In many such cases, Chinese companies often ingrained themselves deeper in the country's mining ecosystems, establishing mineral processing facilities in foreign mining sites and securing the supply chains via proximity. Previous DSET research has mapped how these same features have been replicated in Indonesia's nickel industry, a case where Indonesia's integrated ecosystem of mines, processing plants, refineries, power plants, and related infrastructure made it easier for Chinese firms to process and refine the ore in the country of origin, as opposed to the conventionally preferred option of shipping the material to China for processing.⁶⁹

This vertical integration provides China with significant cost advantages. Control over precursor production lowers input costs for domestic CAM manufacturers and partly reduces exposure to external supply disruptions. In addition, comparatively lower energy costs support large-scale, price-competitive production. By contrast, manufacturers in South Korea and Japan that operate with higher input and energy costs have gravitated toward higher-end, premium NMC chemistries rather than competing directly on volume, with long-range EVs and drones emerging as the key drivers of demand in this segment.⁷⁰

Lower electricity prices and lax environmental standards (EU versus China Example)

The pricing mechanism for battery materials is complex; it is influenced not only by the prices for key upstream metals (lithium, nickel, cobalt, and manganese) as mentioned above, but also involves processing fees (e.g. energy cost), logistics premiums, and discounts for geopolitical risks which leads to the battery production costs for NMC cells in the EU carrying a 70 percent premium compared to the cost in China.⁷¹

Energy cost accounts for 10 percent of CAMs and 20 percent of the AAMs. According to a market report, production takes 15–25 MWh per tonne of CAM.⁷² China's industrial electricity rates are substantially lower than those in Europe (ranging from \$0.08–\$0.11 per kWh in China, compared to \$0.15 to \$0.25 per kWh in the EU), resulting in roughly USD 5/kWh in battery cost differences.⁷³

Weak environmental enforcement furthers this advantage by reducing the processing cost. For example, cathode manufacturing generates fluoride-containing wastewater. Chinese graphite producers use a chemical purification process that is cheaper than the thermal methods required by stricter regulatory regimes in other countries. This in turn generates significant industrial pollution. Despite the consequences, officials are often reluctant to intervene due to the economic importance of the industry.⁷⁴ In addition, the carbon intensity of Chinese synthetic graphite is more than three times that of natural graphite anode material.⁷⁵ Manufacturers operating under more regulatory standards face a structural disadvantage in building up competitive plants at scale.

Price difference

The following table shows the market prices of the three main types of ternary cathode materials included pCAM and CAM in the Chinese market in late 2025:

Table 3: Market Price of NMC⁷⁶
(Unit: USD/Metric Ton)

	pCAM	CAM
NMC 532	~15,825	~20,347
NMC 622	~15,900	~20,069
NMC 811	~16,950	~22,847

Compared to China, suppliers in non-Chinese regions (primarily South Korea, Japan, Europe, and North America) face higher process costs (including labor costs, energy expenses, and stricter environmental regulations). Consequently, the price of NMC 811 produced outside China is 15% to 25% higher.⁷⁷

In addition to manufacturing costs, fragmented supply chain structure results in non-Chinese suppliers incurring more hidden costs. In China, processes ranging from the refining of nickel sulfate

and cobalt sulfate to the synthesis of pCAM and the sintering of CAM typically take place within industrial parks spanning a short distance. In contrast, non-Chinese suppliers often have to transport raw materials and reagents across oceans. For example, South Korean companies source most of their lithium salts from South America or Australia, yet they remain highly dependent on Chinese imports for precursors.⁷⁸ According to our interviews, the total cost of NMC CAM material outside China could be 40–50% higher on average in 2026.⁷⁹

Over the past two decades, China's longstanding history in midstream processing expertise resulted in massive cost and intellectual property advantages that create high barriers to entry for new firms.⁸⁰ Building midstream capacity in allied jurisdictions requires creating a new industry at a structural cost disadvantage. Worse, incumbent producers have demonstrated willingness to flood markets to suppress prices—as with nickel via Indonesian operations and lithium carbonate in 2023–24—undermining nascent Western facilities before they reach scale.⁸¹

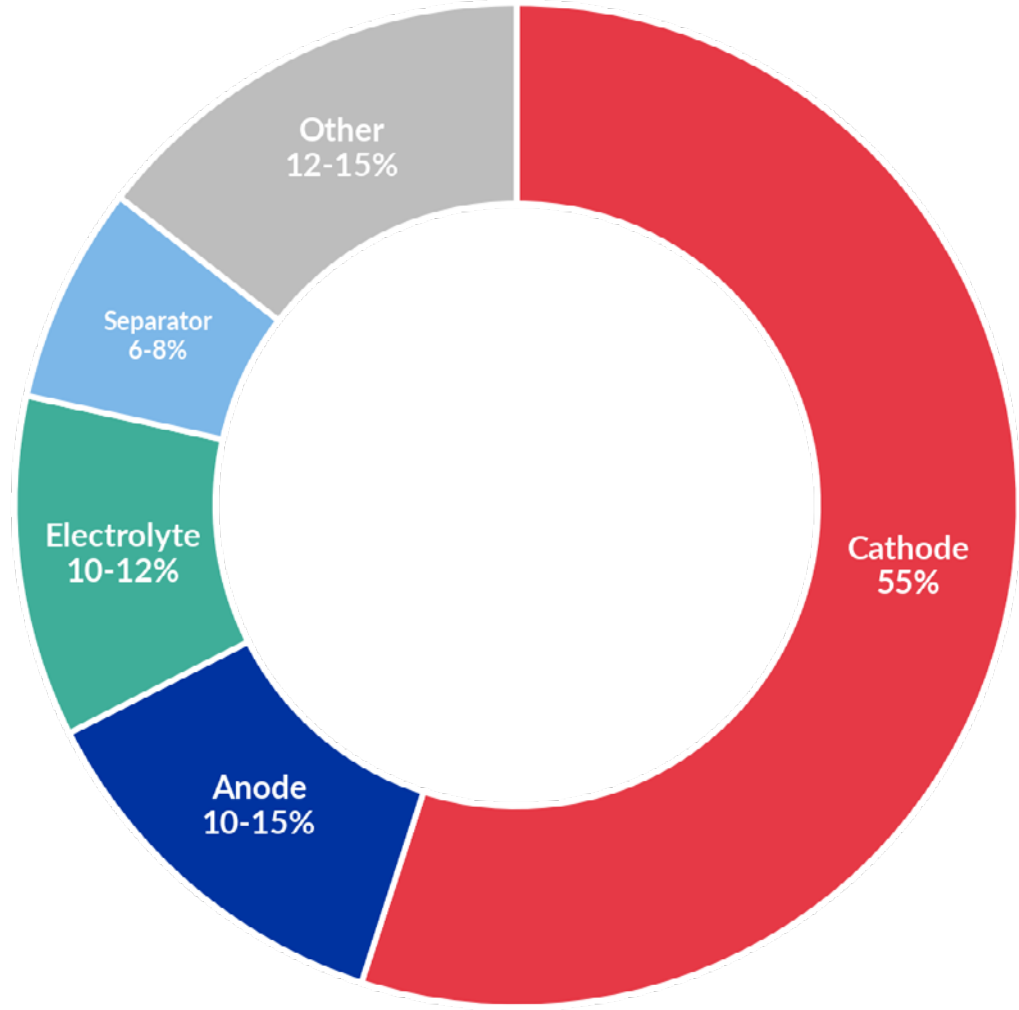
The Primary Driver Behind the Battery Cell Cost Gap

The production concentration of battery material documented in the previous section further translates into a structural cost gap of batteries.

The cathode is typically the most expensive component, and therefore, it drives the cost of an NMC battery cell. Industry estimates of cathode share in finished cell cost range from roughly 40 to 60 percent depending on chemistry, nickel content, and prevailing precursor prices, while the anode active material accounts for approximately 10 to 15 percent.^{82,83}

While graphite is less expensive than cathode materials, the limited availability of alternative suppliers creates a significant bottleneck, as few viable global substitutes currently exist. This asymmetric price structure indicates that policies aimed at de-risking the battery supply chain must prioritize the electrodes.

Figure 4:
Cost of a cell⁸⁴



The costs outlined in the figure are estimations, while actual shares vary based on market fluctuations and the specific NMC chemistry.⁸⁵

The higher portion of cathode in the battery's cost structure is in part due to the cost of the raw materials involved. NMC chemistries rely primarily on cobalt, nickel, and manganese.⁸⁶ Among these inputs, cobalt is the most expensive metal, despite holding a smaller share of the NMC chemistry.⁸⁷ Its higher cost stems from a combination of extreme geographic concentration in the Democratic Republic of the Congo,⁸⁸ persistent ethical and labor concerns, and high price volatility.⁸⁹ These vulnerabilities are compounded by the fact that cobalt is largely mined as a by-product of copper, making its supply poorly responsive to demand shocks.

Manganese contributes to the safety and structural stability within a cathode. It is significantly cheaper and more geographically diversified than either cobalt or nickel. As a result, manganese has become increasingly attractive as manufacturers seek to rebalance performance, cost, and supply chain resilience. This is reflected in growing interest in low-cobalt or cobalt-free chemistries using manganese rich alternatives.⁹⁰

Nickel, by contrast, represents the largest share of material input in NMC cathodes and therefore exerts the greatest influence on overall cathode cost at scale. As battery manufacturers shift toward higher nickel chemistries to achieve greater energy density, demand for battery-grade nickel is expected to increase by 16-fold and 1.8 million tons by 2030.⁹¹ This increases cell makers' exposure to nickel price fluctuation and processing bottlenecks, as battery-grade nickel requires higher purity and more complex refining than nickel used in traditional industrial applications.⁹²

These raw materials must be converted into battery-grade sulfates and other refined chemicals, a stage that carries a significant premium over industrial-grade processing because of strict purity standards and intensive energy use. China dominates this stage; its scale and lower energy costs translate into cost advantages that non-Chinese producers struggle to match. Cell costs therefore reflect not only raw mineral prices

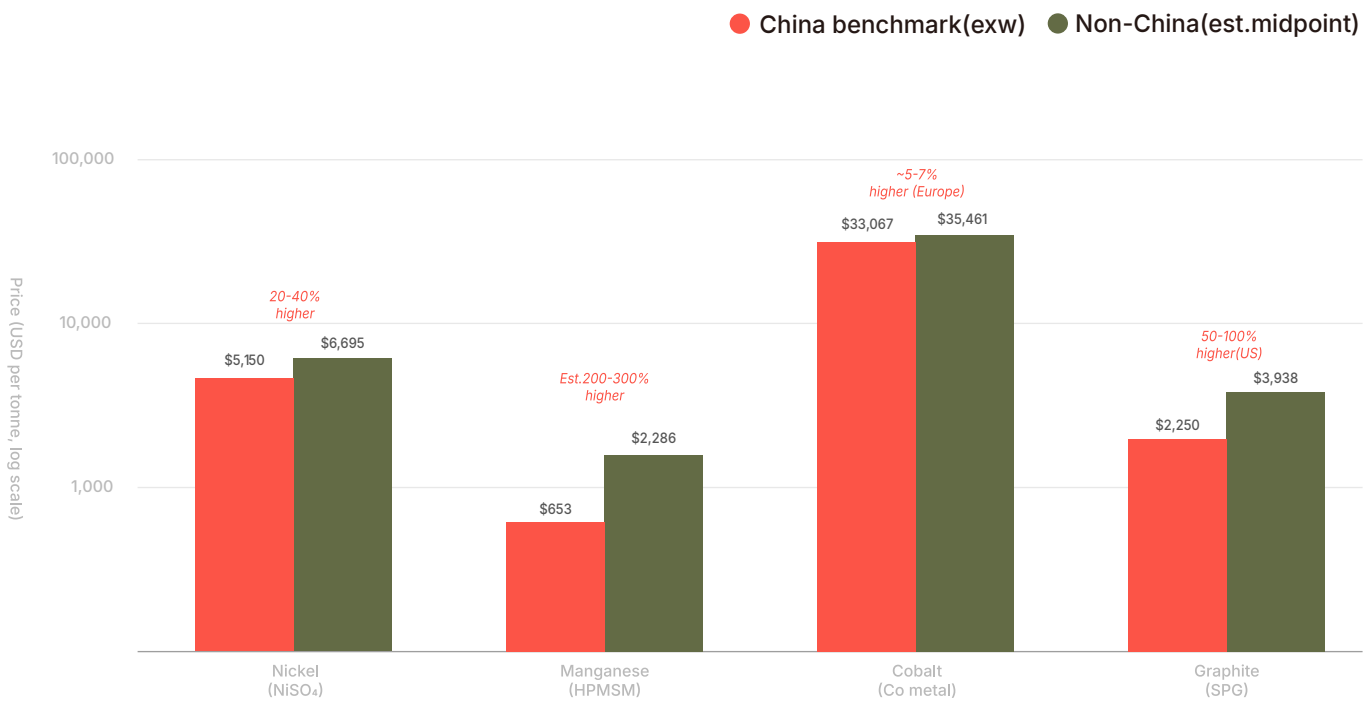
but the cost of transforming those minerals into battery-grade inputs, where Chinese suppliers currently set the global benchmark.

AAMs: Graphite

The anode is generally cheaper than the cathode per unit, but it remains a serious chokepoint. Graphite is the largest material in the battery cell by weight, and the sheer quantity required means it accounts for a meaningful share of total cell cost despite its lower unit price. That low price is itself a function of China's outsized role in graphite production: persistent oversupply has pushed prices down and discouraged investment in alternative supply chains.^{93,94}

This price dynamic creates a disadvantage for non-Chinese anode producers. Unlike materials like cobalt, which can be engineered out of a battery through chemical substitution, or nickel, whose supply base is technically geographically diversified, graphite is present in virtually all commercial lithium-ion anodes and has no near term replacement at scale. Non-Chinese manufacturers who attempt to build a competitive anode supply chain must also absorb higher energy, labor, and environmental compliance costs.

Figure 5: Battery-Grade Critical Minerals: China vs. Non-China Price Comparison



Non-China prices use the midpoint of estimated premium ranges. Y-axis uses a logarithmic scale.
Note: Cobalt is shown as refined metal rather than cobalt sulfate (CoSO₄), because regional CoSO₄ pricing is not publicly available due to the prevalence of bilateral contracts. Co metal prices are therefore used as a proxy.
95,96,97,98,99,100,101

Taken together, China's structural cost advantages across both the cathode and anode active materials demonstrate that the price gap between Chinese and non-Chinese cell manufacturers is built into the supply chain at every processing stage.

Conclusion

China's dominance across the battery supply chain runs deeper than raw materials alone. It permeates across the supply of refined chemicals, precursors, electrode active materials, and the manufacturing of both NMC cathodes and anodes. This dominance – achieved through decades of state-led policy, lax environmental standards, and cheaper energy costs – has created a massive structural barrier that non-Chinese manufacturers cannot easily bypass due to cost gaps that make market competition nearly unbeatable. Securing access to stable supplies of battery materials – namely cathode and anode materials – along with attention to the upstream inputs and processing steps that enable them, remains the most strategic yet understudied lever for battery resilience.

This places particular pressure on economies that lack deep domestic battery material manufacturing capacity but face acute security and reliability demands. Taiwan is one such case. Its battery ecosystem risks being overshadowed by China's outsized cathode production and Taiwan's own industrial structure. The following chapter examines Taiwan's battery landscape in detail, tracing how existing policy frameworks, industrial capabilities, and strategic dependencies shape its options for securing critical battery materials.

Chapter 3

Taiwan's Battery Industry: Growing Capability With Material Vulnerability

While the previous chapter examined how drone battery supply chains (especially in NMC CAM and AAM) are exposed to Chinese material risk and the cost gaps that follow, this chapter turns to the policy implications and what is needed to develop alternative material sources and reduce vulnerability in the face of a supply chain disruption. Taiwan is central to this discussion, as its battery manufacturers occupy a distinctive yet constrained position in the broader effort to establish a viable "non-red" drone supply chain. As this chapter argues, Taiwan's drone battery industry is constrained not by manufacturing expertise, but by domestic production capacity, upstream material dependence, and an absence of coordinated policy support.

Profile of Taiwan's Battery Industry

Taiwan possesses a functioning battery cell manufacturing base. In pack assembly and module integration, Taiwan is globally competitive, holding approximately 13% of the worldwide battery pack market and commanding dominant positions in consumer electronics battery modules (there is over 60% of global notebook battery module production in Taiwan).¹⁰² By leveraging decades of experience in module design, thermal management, and rapid customization, the battery module manufacturers have demonstrated the ability and the desire to meet specialized requirements from clients like Skydio, the leading American drone manufacturer, who is currently suffering battery crisis under sanctions posed by China.^{103,104}

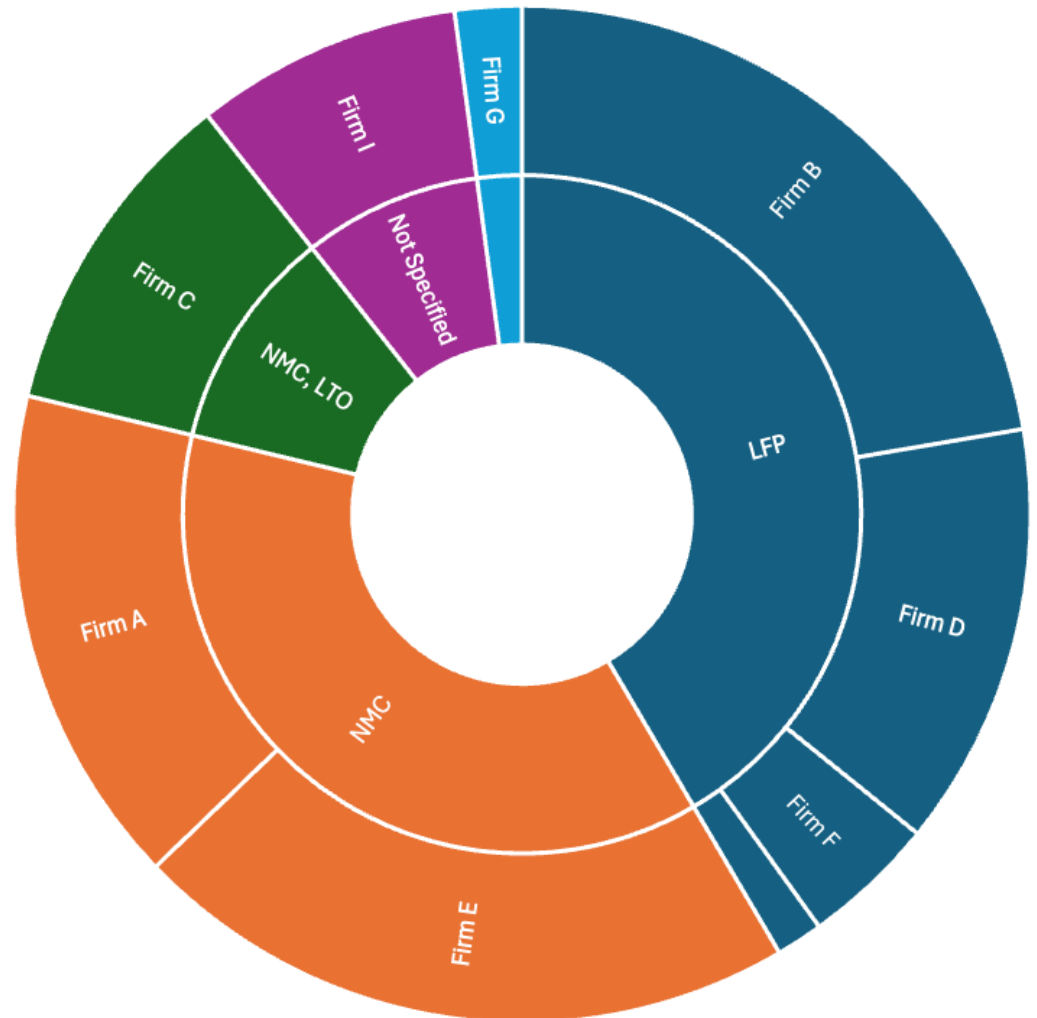
However, the challenge of securing a sufficient and stable supply of battery cells domestically remains a significant bottleneck for Taiwanese battery module manufacturers venturing into the drone market. According to publicly accessible data, as of 2025, Taiwan's total domestic cell production capacity stands at approximately 9.41 GWh per year, spread across a handful of firms. Table 4 summarizes the major domestic producers and their primary chemistries, highlighting the current landscape of Taiwan's upstream capabilities.

Table 4: Taiwanese Battery Manufacturers

(Source: Taiwan's domestic battery cell manufacturing capacity, 2025. Compiled by DSET.)

Manufacturer	Capacity(per year)	Chemistry	Primary Applications
FSET (Formosa Plastics)	2.1 GWh ¹⁰⁵	LFP ¹⁰⁶	E-bus, ESS, UPS
ProLogium	~2 GWh ¹⁰⁷	NMC	EV, ESS, power tools, robotics
Molicel (TCC subsidiary)	1.5 GWh ¹⁰⁸	NMC	EV, ESS, satellite
Hon Hai (Foxconn)	1.27 GWh ¹⁰⁹	LFP	E-bus, ESS
GUS Technology	1 GWh ¹¹⁰	NMC, LTO	E-bus, drones
Cold Electric	0.4 GWh (3 GWh planned) ¹¹¹	LFP	ESS
Amita Technologies	0.2 GWh (1 GWh planned) ¹¹²	NMC, LFP	E-bicycle, drones
Apogee Power	0.14 GWh ¹¹³	LFP	ESS
Others	~0.8 GWh		
Total	~9.41 GWh		

Figure 6:
Taiwan's domestic
battery cell
manufacturing
capacity, 2025.



Despite Taiwan's total battery capacity reaching around 9.4 GW, this amount is split across different chemistries and use-cases. For example, an LFP and an NMC battery are not interchangeable, and even within the NMC category, product lines are divided into specific variations that are incompatible across end products.

Taking a closer look at Taiwan's production capacity for NMC cells, based on a review of Taiwan-listed battery cell manufacturers' annual reports and websites and the Taiwan Battery Association (TBA) membership directory, there are only eight domestic cell manufacturers in Taiwan. Our investigation identifies at least one Taiwanese firm that established a global reputation with significant export track records. It has built up cost advantages in high-performance NMC cells, supplying cells with affordable prices for aerospace launch vehicles, eVTOL aircraft, racecars, and power tools. Following China's October 2025 export controls on lithium-ion batteries exceeding 300 Wh/kg, this firm stands as one of the few non-Chinese manufacturers capable of mass-producing cells above this threshold while sustaining the high discharge rates that aerospace and defense applications require.

Beyond cell manufacturers, Taiwan's module sector contributes pack-engineering and BMS capabilities tailored to drone applications. Pack assembly for drone use requires substantially more welded contact points than consumer electronics to withstand in-flight vibration and minimize internal resistance under high-current discharge; BMS development draws on Taiwan's semiconductor and electronic-control depth.¹¹⁴ These requirements represent distinct technical expertise and proprietary craftsmanship unique to the UAV module integration market.

In particular, two prominent battery module companies, Simplo Technology (新普) and Celxpert Energy (加百裕), have demonstrated a strong capability in capitalizing on these burgeoning opportunities based upon their existing product lines for IT applications such as laptops and smartphones. Celxpert Energy has established a long-term foundation in the drone module sector, and Simplo Technology further highlights that the drone market offers a diverse landscape, since these products yield significantly higher profit margins.^{115,116} However, batteries for drone application remains a rather niche market for them, accounting for less than 10 percent in their total products.¹¹⁷

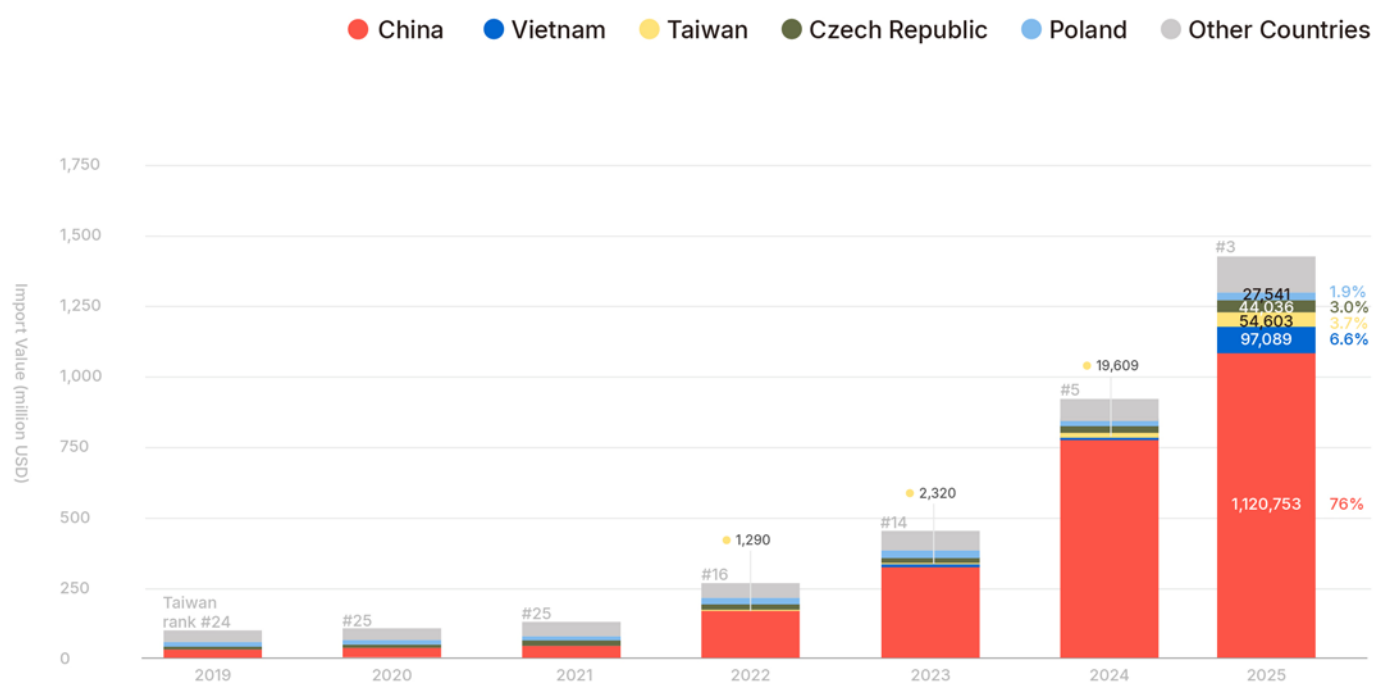
In short, the binding constraint for Taiwan is not downstream capacity. Pack assembly and module engineering are well-developed for drone applications; cell-making capacity is adequate in aggregate, though the high-nickel NMC chemistry that military drones require sits with a handful of producers. The structural gap is that Taiwan has no domestic production of cathode and electrode precursor chemicals, all of which remain primarily sourced from China. Closing this midstream gap, and doing so at the order volumes typical of Taiwan's fragmented small-volume drone industry, is an urgent priority for the Taiwanese government.

**Small Scale,
High Impact: The
Strategic Edge
of Taiwan's NMC
Batteries in Ukraine**

Taiwan's battery industry has demonstrated a strategic foothold in overseas drone markets, most visibly in Ukraine. According to Ukraine State Customs Service data on HS 8507 electric storage batteries, the most recent record as of the first quarter of 2026, Taiwan exported to Ukraine about US\$ 11.85 million worth of battery cells.¹¹⁸ In the data, import value from Taiwan rose from US\$ 0.45 million in 2019 to US\$ 54.6 million in 2025, a roughly 120-fold increase, while net weight grew 7-fold, from 149 to 1,077 tonnes. In terms of ranking, Taiwan moved from 24th in 2019 to 3rd in 2025, trailing only China and Vietnam. This track record demonstrates that Taiwanese firms can sustain high-volume production under demanding conditions when the demand signal and supply chain access are both present.

Figure 7: Ukraine's battery imports under HS 8507 by source country, 2019-2025

(Source: Ukrainian State Customs Service; compiled by DSET)



Ukraine's battery imports under HS 8507 grew roughly fifteenfold between 2019 and 2025, driven by wartime demand for drone batteries, mobile power packs, and grid-resilience storage. Within that expansion, Taiwan rose from rank 24 (US\$453,000) to rank 3 (US\$54.6 million), behind only China and Vietnam. China remained the dominant supplier at 76 percent of 2025 import value.

Moreover, the implied unit value (declared value divided by tonnage) places Taiwanese cells in the upper tier of the Ukrainian market, second only to U.S.-origin cells, consistent with industry interviews indicating it substantiates Taiwanese manufacturers' comparative advantage in high-spec, high-energy-density modules suitable for cold-weather battlefield operations.

Table 5: Top 10 countries by unit cost of Ukraine's battery imports in 2025

(Source: Ukrainian State Customs Service; compiled by DSET)

Country	Import value (kUSD)	Import net weight (t)	Unit cost (USD/ton)
United States	20,934	134	156,224
Taiwan	54,603	1,077	50,699
China	1,120,753	49,966	22,430
Italy	33,968	2,303	14,749
Vietnam	97,089	8,235	11,790
Germany	10,840	1,195	9,071
Czech Republic	44,036	5,481	8,034
Bulgaria	17,385	2,221	7,828
Poland	27,541	5,966	4,616
Slovenia	7,210	2,206	3,268

Another competitive advantage is AS9100D certification, the aerospace industry's gold standard. AS9100D requires operational risk management, configuration management, product safety, counterfeit-parts prevention, and special process control, all of which together impose full supply-chain traceability on certified manufacturers. For Taiwanese cell makers, this credential is a meaningful differentiator in the non-red supply chain conversation and a particularly important asset in the Ukraine market, where battlefield-grade components face elevated counterfeit and tamper risks. As one indication of the credential's commercial value, a Taiwanese cell maker publicly reported in 2024 that one of its ultra-high-power cell models holds the leading market share in eVTOL and drone applications.

This firm's certifications and market position illustrate what Taiwanese cell makers can achieve when international standards align with operational requirements, but the broader picture is more uneven. Other Taiwanese cell manufacturers have positioned themselves for Taiwan's own emerging defense procurement segment, which carries different technical demands. Where the Ukrainian battlefield prioritizes cold-weather robustness and long endurance, Taiwan's coastal environments demand performance under high humidity and intense wind loading. These conditions have pushed some local drone manufacturers toward pouch-format cells, which are lighter and easier to fit into space- and weight-constrained airframes. A Taiwanese supplier with military UAV contracts noted that for eVTOL applications operating under high payloads in complex wind conditions, the performance metric of concern alongside C-rate is the number of start-stop cycles a battery can endure.¹¹⁹

Industry-wide alignment has progressed alongside firm-level initiatives. TBA recently established the "UAV Lithium-ion Battery Development Alliance," designed to coordinate Taiwan's drone battery supply chain across raw materials, cells, and modules. The alliance responds to growing demand for non-red battery sourcing and seeks to leverage Taiwan's existing position in the global supply chain. By supporting members in

pursuing international certifications, it aims to establish "Made in Taiwan" as a credible mark of both technical quality and supply-chain transparency. The alliance has also signed a Joint Development Agreement (JDA) to align battery-material development with target cell specifications and performance requirements.¹²⁰

Yet, these alliance-level efforts may encounter structural limits that individual firms alone cannot resolve. The drone sector remains fragmented, with bespoke specifications that make it difficult for smaller cell producers to reach the volumes needed to compete. To address this, TBA has convened drone manufacturers, module assemblers, and material suppliers to develop standardized lithium-ion battery module specifications for military-grade drones, drawing on dual-layer coating technology to allow multiple domestic manufacturers to mass-produce cells with both high capacity and high discharge rates.¹²¹ A common standard would also reduce the certification costs that currently deter smaller manufacturers from entering the drone market. However, the initiative has struggled to gain traction. Firms are hesitant to align with a unified standard that might dilute their proprietary technological edge, leaving the goal of a standardized domestic supply chain largely aspirational until the market reaches a higher level of maturity.

The Niche Market Constraint of Drone Battery

According to our interviews with Taiwanese battery cell manufacturers, the aggregation of current export numbers to overseas markets and potential domestic procurement plans of the military and public sector for "non-red" batteries would not inspire Taiwanese manufacturers to scale battery cell production. Crucially, the drone battery market in general is a relatively smaller market than EVs and other consumer electronics.¹²² Such a caveat would result in the lack of investment interest for upstream material suppliers and thus, becomes a challenge for Taiwan to establish a non-red drone battery supply chain.

Major cathode producers expressed in the interviews, including a major Japanese supplier, that Taiwan's drone battery market is too small and fragmented to justify dedicating a production line to its high-specification cell requirements. A Belgian cathode supplier further indicated it would only consider opening a dedicated product line for annual orders of at least 1 GWh. For companies scaling nickel-based cathode output to tens of thousands of tons per month to supply EVs, the drone battery market alone cannot sustain capital-intensive CAM/pCAM production without integrating other advanced applications and overseas markets.

Nevertheless, some types of drone batteries still share some similar upstream inputs, particularly the pCAM compounds, with EVs and other high-end applications such as eVTOL and power tools. This report highlights that a stable supply for CAMs and pCAMs would benefit several downstream battery applications simultaneously. Anchoring procurement commitments across multiple battery applications would present a stronger demand signal to upstream suppliers.

To what extent Drones and EVs share upstream capacity

Most of the non-China EVs and military-grade drone cells share most of their upstream supply chain. Both draw on the same refined battery-grade materials—nickel sulfate, cobalt sulfate, manganese sulfate, and lithium hydroxide—and the same pCAM, principally nickel-manganese-cobalt hydroxide. Divergence emerges at two distinct stages further downstream.

The first divergence is at the CAM stage. Specifically, this divide is between mass-market and high-performance applications rather than between EVs and drones. Mass-market EV and grid-storage cells are tuned for moderate discharge rates, long cycle life, and low cost, accepting lower energy density.¹²³ High-performance applications, including military-grade drones, eVTOL aircraft, power tools, and racing cars, converge on high-nickel NMC (NMC 811 and above) optimized for energy density and high C-rates.^{124,125}

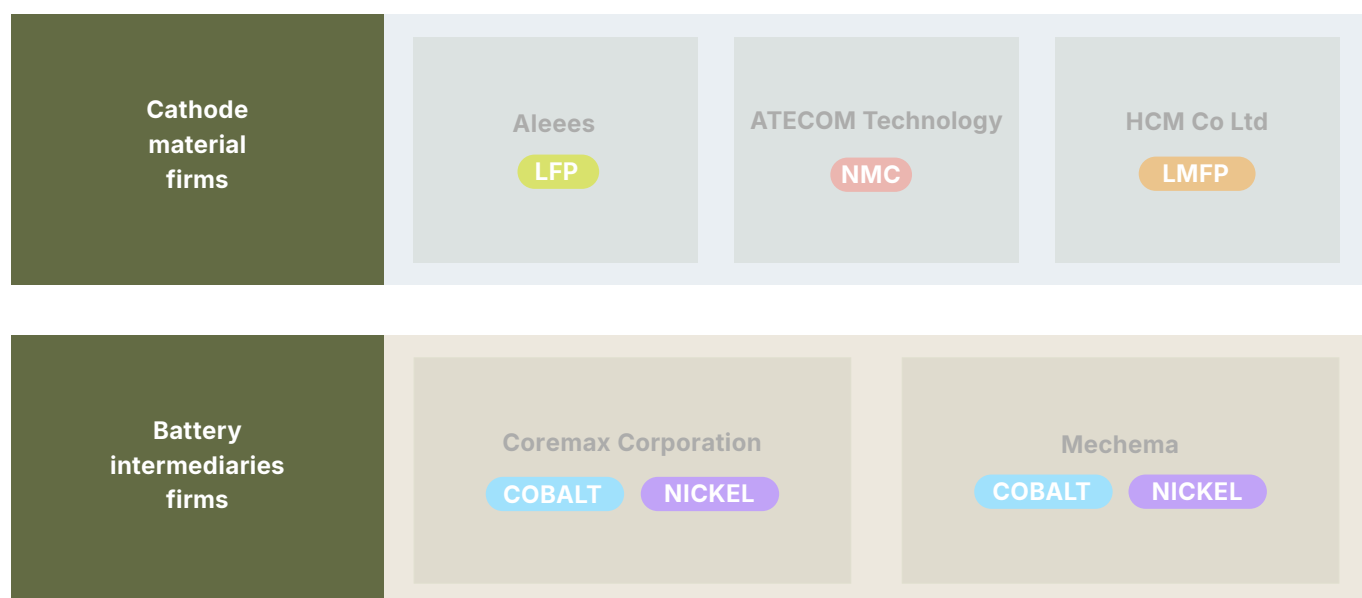
The second divergence is at the cell format and production line itself. EV gigafactories are built around large-format prismatic, pouch, or large 4680 cylindrical cells optimized for mass throughput. Drone applications use smaller cells: 21700 cylindrical for medium- and long-endurance drones, and pouch cells for FPV and some Taiwan-local defense applications. The overlapping demand is therefore narrow. A high-specification cylindrical line can serve drones, eVTOL aircraft, power tools, and premium consumer cells in parallel, but a gigafactory optimized for mass-market EV cells cannot redirect capacity to these niches without months of process re-qualification.

Taiwan's Lack of Local Up/Midstream Material Suppliers Presents Another Significant Challenge to De-Redding the Supply Chain

Despite Taiwan's foothold in cell manufacturing, there is a distinct lack of CAM and pCAM manufacturers operating domestically in Taiwan. While there are some manufacturers that produce specific battery-grade sulfates, Taiwan, like many other countries, lacks a strong domestic base for these materials.

A review of the TBA membership further highlights the absence of domestic NMC cathode production. The association lists only three cathode material firms, Advanced Lithium Electrochemistry (Aleees), HCM CO., LTD, and Coremax Corporation.^{126,127} Among these, most companies focus on lithium iron phosphate (LFP) or related chemistries. Only ATECOM lists NMC materials among its products.¹²⁸ However, closer examination shows that some of their manufacturing footprint is primarily located in China rather than Taiwan.¹²⁹ At the same time, Coremax Corporation and Mechema Chemicals International Corporation (Taiwan-based company not identified by TBA) produce battery-related cobalt and nickel chemical intermediates, but not the CAM or pCAM.^{130,131}

Figure 8: Taiwan's Upstream Firms



ATECOM lists NMC but manufactures in china

Industry interviews indicate that sourcing non-Chinese cathode materials can increase costs by three to four times.¹³² For battery manufacturers, pursuing alternative supply chains requires both technical feasibility and sufficient, predictable demand to justify the additional investment.

At present, however, Taiwan's policy signals remain ambiguous. Market participants often interpret "non-red supply chain" requirements as applying only to the final assembly stage, rather than the origin of critical materials. However, policy frameworks such as the U.S. NDAA address this gap more directly by requiring a high proportion of non-China sourcing at the material level. This distinction is critical, since downstream assembling capacity will become ineffective without secure upstream inputs in a contingency involving blockade or sustained supply disruption.

Taiwan's policy objective should therefore be broader than excluding Chinese inputs from individual procurement contracts. It should be building a credible, verifiable, and scalable non-red drone battery ecosystem. This requires three mutually reinforcing actions, which Chapter 4 elaborates: standards and governance for defense procurement, demand-side scale within the industry and with allies, and proactive engagement with non-Chinese pCAM and CAM producers.

Chapter 4

Policy Recommendations

From the preceding chapters, it's clear that while Taiwan possesses the technical expertise to produce high-performance batteries, the commercial and material foundation for a non-red supply chain remains fragile due to weak market pull aside from the defense need and heavy reliance on Chinese up- and mid-stream inputs. This chapter outlines the foundational steps to secure the supply chain. However, securing sources is only half the battle; sustaining a non-red ecosystem also requires long-term offtake agreements and bridging the significant cost gap with Chinese competitors.

Since other major battery manufacturing countries face similar challenges on midstream inputs, such as battery-grade precursors and cathode active materials, there are some policy gaps emerging on which Taiwan could leverage. Ultimately, Taiwan's entry point into supply chain resilience is at this midstream chokepoint where Chinese dominance is most acutely felt.

Our following policy recommendations reflect this reality. Rather than regurgitate upstream frameworks that Taiwan cannot meaningfully implement, we focus on a concrete three step framework: define what a "non-red" battery supply chain looks like in practice and gradually phase out Chinese components; build scale through standardization and allied export markets; identify and facilitate orders from emerging non-Chinese pCAM and CAM suppliers. It is in this third step where Taiwan's de-risking efforts must begin, even as the broader work of supply chain resilience extends further upstream.

Governance Framework for Non- Red Battery Supply Chains: Disclosure and Decoupling

Taiwan should begin by tightening the legal treatment of battery components within its existing defense and public procurement framework. Because decoupling takes time, the government should establish a clear schedule to ensure that batteries deployed in military systems are not overly dependent on Chinese inputs, especially components for which few or no alternative suppliers exist. Extending the same requirements to non-defense procurement would also give battery firms more incentives to trace their upstream suppliers.

In January 2026, the Public Construction Commission under the Executive Yuan issued a procurement guideline directing government agencies to progressively remove Chinese-made components from the drones they procure.¹³³ The guideline applies a tiered "non-red" standard across the supply chain and reaches the battery, which it places in a tier requiring non-Chinese (but not necessarily Taiwanese) sourcing. According to the document, this restriction will extend to the passive components from 2027 on. The guideline does not reach the materials inside the cell, such as cathode and anode active materials.

Although this guidance is a positive step toward codifying non-red sourcing requirements, we recommend the government be clearer on three points: how far up the supply chain the requirement must reach, whether a procurement guideline carries enough legal force to be enforceable, and what secondary purpose it can serve.

Interviews with Taiwanese battery manufacturers suggest that the absence of a clear definition for "non-red" battery supply chain indirectly encourages firms to remain ambiguous about their suppliers, especially in an industry where Chinese dominates. Thus, the first meaningful step would be establishing multi-tier supplier traceability rules to at least material level in procurement procedure, especially in the defense sector.

The legal scaffolding is largely in place. Article 11 of the National Security Act bars the provision of China-origin products or services in military procurement, and Article 19 of the Defense Industry Development Act

prohibits China-origin critical components and raw materials in the research, production, and maintenance of controlled military products.^{134, 135} The gap is one of scope: battery cells do not appear to be explicitly recognized within the Ministry of National Defense's current controlled military product framework.¹³⁶

Enhancing battery manufacturer's traceability will further allow Taiwan to enter the EU and the US market. The EU recently set up a compliance regime that ramps up the requirement of imported batteries, including: the digital battery passport for industrial packs above 2 kWh, from February 2027; supply-chain due diligence on cobalt, lithium, nickel, and graphite, in force from August 2027; and the Critical Raw Materials Act's 65% ceiling on third-country material supply, benchmarked to 2030.^{137,138,139,140} The audit infrastructure that Taiwan's defense procurement requires will be the same evidence base European customers demand from 2027 onward.

Given China's dominance in battery materials, immediate decoupling is not feasible. Even the U.S. Department of War, which confronts these supply chain risks with virtually unlimited budgets, has acknowledged this reality and set January 2028 as the starting point for phasing in procurement restrictions on advanced batteries from Foreign Entities of Concern.¹⁴¹

Built on Taiwan's earlier procurement guideline in February 2026, Taiwan should continue its efforts to ensure all battery cells for publicly procured drone battery modules to be assembled in Taiwan and all material-tier suppliers, including CAM, pCAM, and AAM, that feed into publicly procured drone batteries should be non-Chinese by 2028. For the upstream material-input requirement specific to defense, it should also be included in the MND's controlled military product list.

The requirement will give companies greater certainty to diversify their upstream suppliers, help the Taiwanese government hold cell suppliers contractually accountable for providing the highest level of material traceability, and better position battery firms in the international market.

Build Scale Through Standardization and Allied Export Markets

Battery and CAM producers consistently raise a concern alongside upstream sourcing: the drone battery market is too fragmented and too small to justify a dedicated product line, and military orders, the only segment that prioritizes supply chain risk over price, represent only a fraction of overall demand. Overcoming this scale problem requires the government to help the battery industry accumulate volume incrementally, including through finding customers that do not yet require China-free specifications.

Building on Taiwan's national drone strategy, Taiwan should consolidate its position in allied defense and high-specification industrial markets. This export pattern delivers three reinforcing benefits. First, battlefield deployment generates the most operationally relevant performance data available. Second, proven reliability under combat conditions builds the credibility Taiwan will need to enter high-specification industries like eVTOL and aerospace, where buyers similarly demand demonstrated robustness. Third, expanding sales into these allied defense and high-specification markets creates the order volume that Taiwanese cell manufacturers need to qualify with reliable upstream suppliers, many of whom enforce minimum order thresholds that smaller buyers cannot meet on their own.

While bespoke batteries offer a defensible niche, Taiwan's strategic priority should be scaling mass production of standardized cells. Drawing on Chapter 3, baseline specifications for military-use should stipulate a common form factor, energy capacity, and C-rate aligned to mission requirements. Standardization also positions Taiwanese manufacturers to pursue the quality, safety, and performance certifications that pre-qualify them for foreign markets. Relevant frameworks include AS9100 (quality management for aerospace and defense suppliers), UN 38.3 (lithium battery transport safety), and IEC 62660 (performance, durability, and safety testing for lithium-ion cells in electric road vehicles).^{142,143,144} For the U.S. defense market specifically, the Department of War maintains its own standards covering form factor (MIL-STD-3078) and performance test methods (MIL-STD-810H), while AS9100D functions as a de facto private benchmark that most NDAA-compliant battery manufacturers display prominently on their websites.^{145,146} Taiwanese manufacturers can

pursue these certifications independently and many already do, but the government should subsidize the cost, particularly for small and mid-sized firms seeking credentials for the first time.

Table 6: Relevant Quality, Safety, and Defense Standards for Drone Batteries

Standard	Governing Body	Key Focuses
Facility Level		
AS9100D	International Aerospace Quality Group (IAQG)	Quality Management Systems (QMS) for aviation, space, and defense organizations. Prioritizes risk management, product safety, and the prevention of counterfeit parts.
Product Level		
UN 38.3	UN Committee of Experts on the Transport of Dangerous Goods	Lithium battery safety during transportation (air, sea, and land). Designed to prevent thermal runaway, fires, or explosions caused by the stresses of shipping.
IEC 62660	International Electrotechnical Commission (IEC)	Performance, reliability, and safety of secondary lithium-ion cells used specifically for the propulsion of electric road vehicles (EVs).
IEC 62133		Safety for small rechargeable, portable batteries and cells.

MIL-STD-3078	U.S. Department of War	Battery interoperability and standardization for U.S. Army equipment. Focuses on streamlining supply chains, reducing system development costs, and ensuring backward compatibility.
MIL-STD-810H	U.S. Department of War	Environmental engineering and material ruggedness. Evaluates how well equipment will survive the environmental stresses throughout its entire service life.

Looking ahead, Taiwan's increasing agglomeration for drone manufacturing also lays the foundation for establishing standardized and modular solutions. As mentioned in the previous chapter, TBA's standardization initiatives and recent alliance on UAV batteries may consolidate Taiwanese battery productivity for drone industries, contributing to a more seamless drone production ecosystem in military-grade drone batteries. Once the standards are established, the government should further assist in expanding the implications of these standards, such as incorporating pre-verified modules in public procurement specifications, escalating them to international standards, and seeking recognition from accreditation bodies.

Secure non-Chinese CAM, pCAM, and AAM supply

Stockpiling can serve as a short-term buffer against supply shocks. Industry interviews indicate that battery-grade CAM can be stored under controlled warehouse conditions for over six months without significant degradation, sufficient to absorb a near-term disruption while alternative supply is mobilized.¹⁴⁷ Beyond that window, the hygroscopicity and reactivity of these processed chemicals demand increasingly tight storage conditions, and the cost of holding inventory begins to outweigh its insurance value.¹⁴⁸ A six-month stockpile is therefore a useful bridging measure, not a substitute for structural supply. Once depleted, Taiwan needs an actual flow of non-Chinese electrode active materials.

Building that flow domestically faces hard constraints. There is little realistic prospect of Taiwanese firms building an active electrode material facility from scratch, nor would an established firm build a new facility without clear emerging demand in the region. The midstream is defined by notoriously thin margins and short contracts, which limit visibility into future volumes and cashflow.¹⁴⁹ South Korea, one of the few sources of large-scale non-Chinese battery-grade graphite, launched a two-year program in April 2026 covering up to 70 percent of the cost difference between domestic graphite and Chinese imports.¹⁵⁰ Even an established non-Chinese midstream producer cannot survive on commercial pricing alone. Investment appetite in the midstream capacity is correspondingly muted compared with the higher-value, more downstream segments of the lithium-ion battery supply chain. Taiwan's domestic capacity of AAM is small but not zero: China Steel Chemical Corporation, a Taiwanese subsidiary of the China Steel group, is among the few local producers of AAM, and targeted government intervention should be designed to keep that product line alive.

For CAM and pCAM, where no comparable domestic capacity exists, sourcing from overseas remains unavoidable. The most direct intervention is to attract emerging non-Chinese CAM and pCAM manufacturers — particularly those with proven patents that have not yet reached commercial scale — and incentivize them to build facilities in Taiwan. Poland's recent move illustrates the model: the Polish government offered a U.S.-based CAM producer up to USD 320 million to support construction of a pCAM manufacturing facility in Poland.^{151,152}

A complementary path runs through private-to-private collaboration, but securing orders from established pCAM and CAM manufacturers, especially with a China-free sourcing requirement, demands corresponding scale. Aggregating demand across bilateral agreements or an allied military industrial base are the most promising way to clear that scale threshold. The Partnership for Indo-Pacific Industrial Resilience (PIPIR), led by the United States, is a promising forum because it aims precisely on military industrial bases. In March 2026, PIPIR endorsed cooperation on shared standards development and aligned procurement approaches for UAV batteries and small motors, which directly targets the scale gap.¹⁵³ Though Taiwan is still merely an observer, the government should signal active interest in joint ventures on CAM production under this framework. Pooling demand across allied buyers raises the willingness of larger CAM producers to commit a product line, and the partnership additionally opens an inroad to cutting-edge R&D programs funded by the Department of War, including the Defense Logistics Agency's Battery Network (BattNet) program and the Industrial Base Policy Office's Batteries and Energy to Advance Commercialization and National Security (BEACONS) program.^{154,155}

A further, more creative pathway uses recycled feedstock to secure offtake agreements. Recycling firms need niche markets willing to absorb the premium associated with their output, and defense procurement is well suited to that role given its tolerance for cost in exchange for supply security. The Taiwanese government could coordinate domestic recycling firms that handle initial battery shredding with battery cell manufacturers, jointly identifying a midstream partner willing to share processing technology in exchange for guaranteed offtake. For instance, an United Kingdom battery-materials recovery firm announced a collaboration with a battery company in April 2026 to build a fully sovereign UK drone battery supply chain by converting end-of-life EV batteries into domestically produced precursors, CAM, pCAM, and AAM for direct reuse in new cells.¹⁵⁶ To establish an additional secure supply line for drones, Taiwan should direct ITRI and domestic battery material companies to advance their R&D efforts and forge technological partnerships with recycling firms in allied nations.

Concluding Remarks

The recommendations in this chapter converge on three structural interventions, each addressing a distinct bottleneck identified in the report. Standards and governance require Taiwan to define a verifiable non-red battery standard from CAM to finished cell, and to embed that standard in defense procurement and export controls. Demand assurance requires converting Taiwan's fragmented small-volume drone-battery market into order volumes that non-Chinese upstream suppliers will commit to, through expanded allied procurement including continued material support to Ukraine, standardization across military-grade cells, subsidized certification costs for smaller manufacturers, and convening allied governments around shared demand. Material supply assurance requires both immediate buffer and longer-term substitution: strategic stockpiles of CAM and AAM for near-term resilience, direct engagement with non-Chinese cathode and precursor manufacturers, structured cooperation with allied recycling specialists, and continued domestic R&D through ITRI and existing battery-materials companies.

These three pillars are mutually dependent. Standards without demand assurance produce certification regimes with no market; demand without supply assurance generates orders that non-Chinese sources cannot fill; supply without standards leaves Taiwan unable to verify what it has procured. Together they begin to redirect Taiwan's drone-battery ecosystem from its current Chinese-dependent equilibrium toward a verifiable allied supply chain, a shift that will not happen through market signals alone.

The upstream segments of the supply chain, including mineral extraction and primary refining, will remain beyond Taiwan's domestic capacity and will depend on engagement with allied partners better positioned in those segments. But the midstream and downstream choices Taiwan makes now will determine both its own industrial position and the credibility with which it can engage allies further up the supply chain. Taiwan would deepen its integration into emerging allied non-red supply chains, while those allied initiatives gain an additional committed offtaker that helps anchor commercial viability against sustained Chinese pricing pressure.

The drone-battery case is one of the major tests of a problem Taiwan will face repeatedly across its dual-use industrial base: how a small, fragmented, high-specification ecosystem secures critical supply when its principal upstream source is controlled by its principal security threat. The policy architecture developed in this report will need to be applied beyond batteries as Taiwan's defense industrialization deepens. In an era of sustained geopolitical pressure, resilience depends on whether a critical-component industry can sustain itself beyond defense procurement alone. The more closely allied governments and industries coordinate in building such industries, the more durable the resulting non-red supply web becomes.

Appendix 1

List of Interviewees

#	ID	Role	Origin	Status
1	A	Senior representative of a Taiwanese lithium-ion cell manufacturer	TW	Industry / Cell maker
2	B	Representative of a Taiwanese battery industry body	TW	Trade Association
3	C	Senior representative of a Taiwanese battery pack assembler	TW	Industry / Pack assembler
4	D	Senior representative of a major pCAM/ CAM supplier	JP	Industry / Materials supplier
5	E	Senior representative of a major CAM supplier	JP	Industry / Materials supplier
6	F	Senior representative of a Taiwanese battery pack assembler / drone battery manufacturer	TW	Industry / Pack assembler
7	G	Senior government officials	US	Government / Defense policy
8	H	Senior representative of a Taiwanese pouch lithium-ion cell startup	TW	Industry / Cell maker

9	I	Taiwanese government foreign service officer	TW	Government / Diplomatic
10	J	Junior representative of a major battery-grade materials manufacturer (lithium compounds)	US	Industry / Materials supplier
11	K	Senior representatives of a major NMC pCAM/ CAM supplier	BE	Industry / Materials supplier

Appendix 2

Glossary of Relevant Terms

Glossary of Relevant Terms

1	Anode Active Material	AAM
2	Cathode Active Material	CAM
3	Electric Vehicle	EV
4	Electric Vertical Take-Off and Landing	eVTOL
5	Energy Storage System	ESS
6	First Person View	FPV
7	Foreign Entity of Concern	FEOC
8	Lithium Cobalt Oxide	LCO
9	Lithium ion	Li-ion
10	Lithium Iron Phosphate	LFP
11	Lithium Manganese Oxide	LMO
12	Lithium Manganese Iron Phosphate	LMFP
13	Lithium Nickel Manganese Oxide	LNMO

14	Lithium Polymer	Li-Po
15	Lithium-ion Battery	LiB
16	Nickel Cobalt Aluminum	NCA
17	Nickel Manganese Cobalt	NMC
18	Precursor Cathode Active Material	pCAM
19	Uninterruptable Power Supply	UPS
20	Unmanned Aerial Vehicle	UAV

References

1. 國防部軍備局生產製造中心, "無人機(甲式)等5項採購標案," July 22, 2025, <https://web.pcc.gov.tw/tps/tp/common/TpAppeal/query/getInitialAppealView?pkTA=NzAwNzMyNTU%3D>.
2. 方瑋立, 國防部:採購 20 餘萬架無人機 國產優先 - 自由軍武頻道, January 22, 2026, <https://def.ltn.com.tw/article/breakingnews/5318422>.
3. The defense budget was passed in May 2026, but was significantly cut to only keep purchases from the U.S. government, completely cutting out funding for domestic defense initiatives.
4. 經濟日報, "經部盼 2030 年無人機月產能 10 萬台 拚外銷占比 5 成 | 政經焦點 | 要聞," 經濟日報, accessed May 25, 2026, <https://money.udn.com/money/story/7307/9516928>.
5. Jonathan Harman, "Taiwan's Emerging Indigenous Drone Industry—An Overview," Global Taiwan Institute, February 11, 2026, <https://globaltaiwan.org/2026/02/tw-drone-production/>.
6. Ting-Wei Lin, The Invisible Drone Wall: Taiwan's Quiet Support for a China-Free European Drone Supply Chain - Research Institute for Democracy, Society and Emerging Technology (DSET, 2026), <https://dset.tw/en/research/the-invisible-drone-wall-taiwans-quiet-support-for-a-china-free-european-drone-supply-chain/>.
7. The Economist, "Taiwan's bid to export drones free of Chinese parts is taking off," The Economist, March 12, 2026.
8. DSET interview with B. The specific Chinese suppliers serving Taiwanese drone manufacturers are not publicly disclosed; according to industry surveys, the largest and best-known Chinese drone-battery supplier is Tattu, the drone-battery brand of Grepow. See "Top 10 Drone Battery Manufacturers in China," Tycorun, accessed April 30, 2026, <https://www.tycorun.com/blogs/news/top-10-drone-battery-manufacturers-in-china>.
9. "Buy Batteries for Drones and FPV," R202X, accessed May 12, 2026, <https://r202x.com/akumulatory-dlia-droniv/>.
10. "Lithium-Ion Battery Packs for FPV Drones," BTRY Energy, accessed May 12, 2026, <https://btry.energy/en/c/akumulatory-dlya-fpv-droniv>.
11. 經濟日報新聞部, "逆風中的超級電芯國家隊," 經濟日報, accessed August 8, 2025, https://money.udn.com/SSI/2024/topic_battery_cell/.
12. DSET interview with B.
13. "Five Trusted Industry Sectors Promotion Plan(2024-2028)," Website, National Development Council, National Development Council, July 8, 2025, https://www.ndc.gov.tw/en/Content_List.aspx?n=73E8570703E7056A.
14. Ministry of Commerce of China, "商务部 科技部公告 2025 年第 28 号 关于调整发布《中国禁止出口限制出口技术目录》的公告," July 15, 2025, https://fms.mofcom.gov.cn/zcfg/jsjckzcfg/art/2025/art_ba35a101c22c4f6e844f749cb0a98552.html.
15. Ministry of Commerce of China, "商务部公告 2025 年第 13 号 公布将 15 家美国实体列入出口管制管控名单," March 4, 2025.
16. The Blue UAS Framework, administered by the U.S. Defense Innovation Unit (DIU) and authorized under Section 848 of the FY 2020 NDAA and the American Security Drone Act of 2023, restricts U.S. military procurement of unmanned aerial systems containing components from "covered foreign entities." Its enumerated scope covers airframes, flight controllers, communication and data-link modules, cameras and gimbals, ground-control software, and network-connectivity components, but does not include batteries or battery-grade materials. See Defense Innovation Unit, "Blue UAS Cleared List," U.S. Department of Defense, accessed April 30, 2026, <https://bluelist.appsplatformportals.us/>.
17. National Defense Authorization Act for Fiscal Year 2026, S.1071, Senate 119th (2025-2026) (2025), <https://www.congress.gov/bill/119th-congress/senate-bill/1071/text>.
18. Maria Varenikova, "Ukraine Reaches a Milestone: Making 'China-Free' Drones," World, The New York Times, March 11, 2026, <https://www.nytimes.com/2026/03/11/world/europe/ukraine-drones-china.html>.

19. 経済産業省貿易経済安全保障局, "経済安全保障に関する産業・技術基盤強化 アクションプラン," Japanese Government, May 30, 2025, https://www.meti.go.jp/policy/economy/economic_security/250530actionplanr2.pdf.
20. Directorate-General for Environment, "New Law on More Sustainable, Circular and Safe Batteries Enters into Force - Environment," European Commission, August 17, 2023, https://environment.ec.europa.eu/news/new-law-more-sustainable-circular-and-safe-batteries-enters-force-2023-08-17_en.
21. "The Ultimate Guide to FPV Battery," Grepow, February 11, 2025, https://secure.livechatinc.com/customer/action/open_chat?license_id=17875743&group=0&embedded=1&widget_version=3&unique_groups=0&organization_id=c82a1d5d-4075-4d51-9cc1-d918c441ba8f&use_parent_storage=1&x-region=us-south1.
22. DSET interview with C, H, and A.
23. "LFP vs. NMC Battery," NBCELLENERGY, accessed May 12, 2026, <https://nbcellenergy.com/lfp-vs-nmc-battery/>.
24. BloombergNEF, "Lithium-Ion Battery Pack Prices Fall to \$108 Per Kilowatt-Hour, Despite Rising Metal Prices," December 9, 2025. <https://about.bnef.com/insights/clean-transport/lithium-ion-battery-pack-prices-fall-to-108-per-kilowatt-hour-despite-rising-metal-prices-bloombergnef/>
25. Cylindrical cells are named by their physical dimensions in millimeters: the 18650 measures 18 mm in diameter and 65 mm in length, the 21700 measures 21 mm by 70 mm. A single such cell delivers only about 3.7 volts nominal and a few thousand milliamp-hours of capacity, far below what a drone's propulsion motors and avionics require. Drone batteries are therefore assembled into multi-cell packs. Pack assemblers combine cells using series-parallel notation: in a "4S2P" pack, four cells connected in series determine the pack's voltage and two such series strings connected in parallel determine its capacity, for a total of eight cells per pack.
26. According to our interviews, the 21700 battery is widely used in military-grade drones in the Ukraine market. Their energy density is approximately 242 Wh/kg.
27. Alex K. Koech et al., "Exploring the Anode Materials for Lithium-Ion Batteries: A Review," Next Research 2, no. 3 (2025): 100442, <https://doi.org/10.1016/j.nexres.2025.100442>
28. "A Comprehensive Review of Advancements in Powering and Charging Systems for Unmanned Aerial Vehicles," accessed March 10, 2026, <https://arxiv.org/html/2511.13122v1>.
29. "Electrolyte Fill Requirements - Battery Design," accessed March 10, 2026, <https://www.batterydesign.net/electrolyte-fill-requirements/>.
30. "BU-306: What Is the Function of the Separator?," Battery University, accessed March 10, 2026, <http://www.batteryuniversity.com/article/bu-306-what-is-the-function-of-the-separator/>
31. Marie and Gifford, Developments in Lithium-Ion Battery Cathodes.
32. Srihari Mulgund, "Why Are All Eyes on LMFP, an LFP Battery with a Manganese Booster?," EY, February 13, 2024, https://www.ey.com/en_in/industries/automotive/how-lmfp-batteries-can-power-india-s-electric-vehicle-market.
33. C-rate is the rate at which a battery is discharged relative to its rated capacity. A 1C discharge drains the cell's full nominal capacity in one hour; a 10C rate drains it in six minutes. For a 3,000 mAh cell, a 10C discharge corresponds to 30 amperes of continuous current draw. Higher C-rates deliver more peak power but generate more heat and shorten cycle life. "What Is a Battery C-Rate? Definition and Calculations," Ossila, accessed March 10, 2026, <https://www.ossila.com/pages/what-is-battery-c-rate>.
34. Commercially available high-discharge competition FPV racing packs at 150C continuous (300C burst). See "Ovonic Rebel 2.0 6S LiPo Battery 1550mAh 6S1P 150C 22.2V FPV LiPo Battery," product specification, accessed May 11, 2026, <https://www.ovonicshop.com/products/ovonic-22-2v-150c-6s-2800mah-lipo-battery-xt60-plug-for-6-7quad-range-fpv>.
35. "Battery for FPV Drone: How to Choose a Battery, Use and Maintain It Properly," Grif, January 30, 2026, <https://drongrif.com/en/everything-you-need-to-know-about-batteries-for-fpv-drones/>.

36. "Battery for FPV BTRY 6s2p Molicel (INR21700-P42A)," BTRY Energy, accessed May 11, 2026, <https://btry.energy/ru/p/lity-ionnyy-akumulyator-btry-6s2p-molicel-inr21700-p42a-1b3>.
37. Aharon Etengoff, "How Do EV Battery Cell Charge and Discharge Rates Compare?," EV Engineering & Infrastructure, February 6, 2024, <https://www.evengineeringonline.com/how-do-ev-battery-cell-charge-and-discharge-rates-compare/>.
38. Zhenzhen Wu et al., "Ni-Rich Cathode Materials for Stable High-Energy Lithium-Ion Batteries," Nano Energy 126 (July 2024): 109620, <https://doi.org/10.1016/j.nanoen.2024.109620>.
39. Matthew Greenwood et al., "A Bottom-up Performance and Cost Assessment of Lithium-Ion Battery Pouch Cells Utilizing Nickel-Rich Cathode Active Materials and Silicon-Graphite Composite Anodes," Journal of Power Sources Advances 9 (June 2021): 100055, <https://doi.org/10.1016/j.powera.2021.100055>.
40. "NMC Lithium-Ion Batteries Market Size, Share & Trends, 2035," accessed March 10, 2026, <https://www.marketgrowthreports.com/market-reports/nmc-lithium-ion-batteries-market-113909>.
41. Although the fundamental ratio is the same, EV and drone cells are different, as they are engineered for different power profiles. DSET interview with E.
42. "What Is the NMC 811 Battery? What Are Its Features? | Battery Monday," accessed March 18, 2026, <https://www.grepow.com/blog/what-is-the-nmc-811-battery-what-are-its-features-battery-monday.html>.
43. DSET interview with A.
44. Bojan Goluh, "The Role of the Anode in Lithium-Ion Battery Technology," Aichelin: Industrail Furnace Solution, accessed March 18, 2026, <https://www.aichelin.at/en/products/battery-materials/anode-materials>.
45. P. U. Nzereogu et al., "Anode Materials for Lithium-Ion Batteries: A Review," Applied Surface Science Advances 9 (June 2022): 100233, <https://doi.org/10.1016/j.apsadv.2022.100233>.
46. Goluh, "The Role of the Anode in Lithium-Ion Battery Technology."
47. Nzereogu et al., "Anode Materials for Lithium-Ion Batteries."
48. Volta Foundation, "A Brief Introduction to Graphite," Volta Foundation, February 10, 2024, <https://url.htx.mybluehost.me/a-brief-introduction-to-graphite/>.
49. "Battery Anode Materials Market Size & Trends Report, 2030," accessed March 18, 2026, <https://www.grandviewresearch.com/industry-analysis/battery-anode-materials-market-report>.
50. admin, "Natural vs. Synthetic Graphite," GraphiteHub, October 19, 2024, <https://graphitehub.com/natural-vs-synthetic-graphite/>.
51. Understand Lithium Battery Anode Material-Spherical Graphite – ALPA Powder Equipment, n.d., accessed March 18, 2026, <https://www.alpapowder.com/112127/>.
52. Sheng Chen et al., "Natural Graphite Anode for Advanced Lithium-Ion Batteries: Challenges, Progress, and Perspectives," Chemical Engineering Journal 503 (January 2025): 158116, <https://doi.org/10.1016/j.cej.2024.158116>.
53. "The Global Midstream and Downstream Battery Supply Chain, 2024 – Charts – Data & Statistics," IEA, accessed March 19, 2026, <https://www.iea.org/data-and-statistics/charts/the-global-midstream-and-downstream-battery-supply-chain-2024>.
54. Tae-Yoon Kim et al., "With New Export Controls on Critical Minerals, Supply Concentration Risks Become Reality – Analysis," IEA, October 23, 2025, <https://www.iea.org/commentaries/with-new-export-controls-on-critical-minerals-supply-concentration-risks-become-reality>.
55. Ibid

56. IEA, "The Global Midstream and Downstream Battery Supply Chain, 2024 – Charts – Data & Statistics."
57. "What Is Natural Graphite Supply Chain & Market Prices | Benchmark," Benchmark Mineral Intelligence, accessed March 12, 2026, <https://www.benchmarkminerals.com/glossary/what-is-graphite>.
58. "Here's the Top 10 List of Lithium Hydroxide Companies 2025 | Global Growth Insights," accessed March 19, 2026, <https://www.globalgrowthinsights.com/blog/here-s-the-top-10-list-of-lithium-hydroxide-companies-2025-global-growth-insights-923>.
59. "China to Overtake Australia as World's Top Lithium Miner by 2026, Fastmarkets Says | Reuters," accessed March 19, 2026, <https://www.reuters.com/markets/commodities/china-overtake-australia-worlds-top-lithium-miner-by-2026-fastmarkets-says-2025-06-25/>.
60. "PowerPoint Presentation," n.d., accessed March 19, 2026, <https://giyanimetals.com/media/attachments/2025/07/24/giyani-presentation-july-2025-2.pdf>.
61. IEA, "The Global Midstream and Downstream Battery Supply Chain, 2024 – Charts – Data & Statistics."
62. "Battery Grade High Purity Manganese Sulphate Market Demand Dynamics: Insights 2025-2033," January 10, 2026, <https://www.marketreportanalytics.com/reports/battery-grade-high-purity-manganese-sulphate-27947>.
63. Andrew Gulley, "The Development of China's Monopoly over Cobalt Battery Materials," *Mineral Economics* 37 (June 2024): 619–31, <https://doi.org/10.1007/s13563-024-00447-w>.
64. Georgios Bartzas and Konstantinos Komnitsas, "Cradle to Gate Life-Cycle Assessment of Battery Grade Nickel Sulphate Production through High-Pressure Acid Leaching," *Science of The Total Environment* 952 (November 2024): 175902, <https://doi.org/10.1016/j.scitotenv.2024.175902>.
65. Kim et al., "With New Export Controls on Critical Minerals, Supply Concentration Risks Become Reality – Analysis."
66. "Most of the World's Cobalt Is Mined in the Democratic Republic of Congo, but Refined in China," *Our World in Data*, accessed May 12, 2026, <https://ourworldindata.org/data-insights/most-of-the-worlds-cobalt-is-mined-in-the-democratic-republic-of-congo-but-refined-in-china>.
67. Klara Vlahčević Lisinski, "The Silent Cartel: How Chinese Companies Came to Dominate Critical Mineral Markets," *New Lines Institute*, August 13, 2025, <https://newlinesinstitute.org/tech-econ-sov-sec/the-silent-cartel-how-chinese-companies-came-to-dominate-critical-mineral-markets/>.
68. Paul Nantulya, "China's Critical Minerals Strategy in Africa," *Africa Center*, December 9, 2025, <https://africacenter.org/spotlight/china-africa-critical-minerals/>.
69. Elizabeth Frost et al., *Unveiling the Hidden Agenda Behind China's Green Ambitions - Research Institute for Democracy, Society and Emerging Technology*, December 17, 2025, <https://dset.tw/en/research/unveiling-the-hidden-agenda-behind-chinas-green-ambitions/>.
70. bruce.li, "Korean, Chinese, and Japanese Battery Giants Race for U.S.-European Market Share: A Full-Spectrum Analysis of Technology, Costs, and Strategy," *Solution 1*, May 28, 2025, <https://solution1.com.tw/korean-chinese-and-japanese-battery-giants-race-for-u-s-european-market-share-a-full-spectrum-analysis-of-technology-costs-and-strategy/>.
71. "The EV Manufacturing Cost Gap: Why European Carmakers Are Losing Ground to China - Energy News," accessed March 19, 2026, <https://energynews.biz/the-ev-manufacturing-cost-gap-why-european-carmakers-are-losing-ground-to-china/>.
72. "Lithium Ion Battery Cathode Market in Asia | Report - IndexBox - Prices, Size, Forecast, and Companies," accessed May 12, 2026, <https://www.indexbox.io/store/asia-lithium-ion-battery-cathode-market-analysis-forecast-size-trends-and-insights/>.
73. Ocatsaros, "China Regains Number One Spot in BloombergNEF's Global Lithium-Ion Battery Supply Chain Ranking," *BloombergNEF*, May 13, 2025, <https://about.bnef.com/insights/clean-energy/china-regains-number-one-spot-in-bloombergnefs->

global-lithium-ion-battery-supply-chain-ranking/.

74. "China Pollution Caused by Graphite Mining for Smartphone Battery - Washington Post," accessed March 19, 2026, <https://www.washingtonpost.com/graphics/business/batteries/graphite-mining-pollution-in-china/>.

75. "Infographic: China Controls Three-Quarters of Graphite Anode Supply Chain," accessed March 19, 2026, <https://source.benchmarkminerals.com/article/infographic-china-controls-three-quarters-of-graphite-anode-supply-chain>.

76. Peng Zhuo, "New Energy Vehicle Index Rises 1.32%, Lithium Iron Phosphate Average Quote Rises 2350 Yuan/Ton | Industry Weekly Report," 21st Century Business Herald, November 4, 2025, <https://www.21jingji.com/article/20251104/herald/61faeb66508d36347e9ac8263414b68a.html>, accessed on 22 May, 2025.

77. "Lithium Ion Battery Cathode Market in Asia | Report - IndexBox - Prices, Size, Forecast, and Companies."

78. Sarah Chea, "Korean Battery Makers Work to Counter China's Materials Dominance," Korea JoongAng Daily, May 8, 2023, <https://koreajoongangdaily.joins.com/2023/05/08/business/industry/korea-lithium-battery-lithium/20230508161806170.html>.

79. DSET interview with K.

80. U.S. Department of Energy, "2021-2024 Four Year Review of Supply Chains for the Advanced Batteries Sector," December 2024, <https://www.energy.gov/sites/default/files/2024-12/20212024-Four%20Year%20Review%20of%20Supply%20Chains%20for%20the%20Advanced%20Batteries%20Sector.pdf>.

81. Vishakha Saxena, "Spiralling China Lithium Prices Hit 26-Month Low on Supply Glut," Asia Financial, November 26, 2023, <https://www.asiafinancial.com/spiralling-china-lithium-prices-hit-26-month-low-on-supply-glut>.

82. DSET interview with B.

83. IDTechEx, "Battery Cell Costs Drop to Almost US\$100/kWh, Despite Lithium Price Volatility," November 13, 2025, <https://www.prnewswire.com/news-releases/battery-cell-costs-drop-to-almost-us100kwh-despite-lithium-price-volatility-finds-idtechex-302614085.html>.

84. DSET interview with B.

85. IDTechEx, "Battery Cell Costs Drop to Almost US\$100/kWh, Despite Lithium Price Volatility."

86. "Cathode Studies: New Opportunities in Li-Ion Batteries," Hidden Analytical, March 11, 2021, <https://www.hiddenanalytical.com/blog/cathode-studies-batteries/>.

87. Greenwood et al., "A Bottom-up Performance and Cost Assessment of Lithium-Ion Battery Pouch Cells Utilizing Nickel-Rich Cathode Active Materials and Silicon-Graphite Composite Anodes."

88. Lucia Mancini et al., "Assessing Impacts of Responsible Sourcing Initiatives for Cobalt: Insights from a Case Study," Resources Policy 71 (June 2021): 102015, <https://doi.org/10.1016/j.resourpol.2021.102015>.

89. International Banker, "Cobalt Prices Have Soared Over the Last Year: Here's Why," International Banker, February 6, 2026, <https://internationalbanker.com/brokerage/cobalt-prices-have-soared-over-the-last-year-heres-why/>.

90. "What Makes Manganese a Better Option than Cobalt?," Manganese X Energy Corp., n.d., accessed March 10, 2026, <https://www.manganesexenergycorp.com/what-makes-manganese-a-better-option-than-cobalt/>.

91. Lithium Hydroxide and Nickel Sulfate Producers Will Rule the EV Battery Roost - GT Resources Inc., n.d., accessed March 10, 2026, <https://gtresourcesinc.com/archives/investors/articles/lithium-hydroxide-and-nickel-sulfate-producers-will-rule-the-ev-battery-roost>.

92. Lithium Hydroxide and Nickel Sulfate Producers Will Rule the EV Battery Roost - GT Resources Inc., n.d., accessed March 10, 2026, <https://gtresourcesinc.com/archives/investors/articles/lithium-hydroxide-and-nickel-sulfate-producers-will-rule-the-ev>.

battery-roost.

93. "Material Content in Different Anode and Cathodes – Charts – Data & Statistics," IEA, accessed March 18, 2026, <https://www.iea.org/data-and-statistics/charts/material-content-in-different-anode-and-cathodes>.
94. Conrad Beissel, "Trade war fallout: How graphite became a key focus in US-China relations," Jan 13, 2025. ChemAnalyst News.
95. Polina Sparks, "Cobalt Sulfate: The State of Play and What's to Come," MMTA, September 30, 2024, <https://mmta.co.uk/cobalt-sulfate-the-state-of-play-and-whats-to-come/>.
96. Solomon Cefai, "China's Cost Advantages, Improving Demand Overshadow Western Incentives for Manganese Sulfate Production: Firebird CEO," Fastmarkets, March 21, 2024, <https://www.fastmarkets.com/insights/chinas-cost-advantages-improving-demand/>.
97. Yiwen Ju, "Can China's Cheaper Nickel Sulfate Make Its Way Overseas?," Fastmarkets, June 30, 2023, <https://www.fastmarkets.com/insights/can-chinas-cheaper-nickel-sulfate-make-its-way-overseas/>.
98. Sybil Pan, "China's Nickel Sulfate Market Rangebound; Global Nickel Sulfate Assessed at Wide Range," Fastmarkets, August 27, 2024, <https://www.fastmarkets.com/insights/chinas-nickel-sulfate-market-rangebound/>.
99. Angeline Shi, "Chinese Cobalt Refiners Shift to Metal Dissolution amid DRC Quotas," Fastmarkets, October 3, 2025, <https://www.fastmarkets.com/insights/chinese-cobalt-refiners-shift-to-metal-dissolution-amid-drc-quotas/>.
100. Gracelin Baskaran and Meredith Schwartz, "Stabilizing Cobalt Markets: A Price Floor for U.S. Minerals Security," CSIS, December 10, 2025, <https://www.csis.org/analysis/stabilizing-cobalt-markets-price-floor-us-minerals-security>.
101. Mark Golden, "Confronting China's Grip on Graphite for Batteries," STEER, Stanford, July 22, 2025, <https://energy.stanford.edu/news/confronting-chinas-grip-graphite-batteries>.
102. Ferry Tim, "Taiwan's battery sector," Euroview, May 21, 2021, <https://euroview.ecct.com.tw/category-inside.php?id=608>.
103. Ferry, "Taiwan's battery sector."
104. Ollie Chang, "US drone maker Skydio faces battery crisis amid China sanctions", Dec 2, 2024, <https://www.digitimes.com/news/a20241128PD213/taiwan-fire-sales-dji-government.html>.
105. TCC to Invest \$350 Million in New Gigafactory - Molicel, Announcement, March 20, 2021, <https://www.molicel.com/newsroom/tcc-to-invest-usd-350-million-in-gigafactory/>.
106. Formosa Smart Energy Tech Corporation, "FSET Announces Completion of Battery Cell Factory in Changhua Coastal Industrial Park," Formosa Smart Energy Tech Corporation, October 4, 2024, <https://www.fpg.taipei/en/issue-news/2023/351>.
107. NetAdmin, "GUS Technology completes construction of its first GWh-grade lithium battery cell gigafactory [格斯科技首座 GWh 鋰電池芯超級工廠落成]", April 28, 2023, <https://www.netadmin.com.tw/netadmin/zh-tw/snapshot/3B20F6FB2BA54C87A86782E590034545>.
108. Molicel, TCC to Invest \$350 Million in New Gigafactory - Molicel, Announcement, March 20, 2021, <https://www.molicel.com/newsroom/tcc-to-invest-usd-350-million-in-gigafactory/>.
109. Economic Daily News, "Taiwan's Battery Cell National Team: An Inside Look at the Industry's Transformation and Strategic Roadmap [台灣電芯國家隊：直擊電池產業轉型與佈局]", Economic Daily News, October 16, 2024, https://money.udn.com/SSI/2024/topic_battery_cell/.
110. "Taiwan's ProLogium Opens EV Battery 'Gigafactory' in Taoyuan | Taiwan News | Jan. 25, 2024 17:09," January 25, 2024, <https://taiwannews.com.tw/en/news/5085166>.
111. Rich Club, "Cold Electric's Q1 revenue surpasses last year's total; launches major 3GW expansion[長庚能源 Q1 營收超越去年 啟動大擴產 3GW]," July 31, 2024, <https://www.sinotrade.com.tw/richclub/news/68874a228ff59b56a6e75559>.

112. Economic Daily News, " 有量桃園廠目前產品僅 200MWh，長期目標 10GWh," Economic Daily News, March 5, 2024, <https://money.udn.com/money/story/123948/7808210>.
113. Apogee Power, "Apogee Power ESS: Explosion-Proof and Long-Life Energy Storage System [寶電儲能：寶電儲能防爆長效型儲能系統]," Apogee Power, viewed on March 16, 2026, [https://apogeepower.com.tw/#:~:text=100%E8%90%AC%E9%A1%86%E3%80%82-,%E5%B9%B4%E7%94%A2%E8%83%BD144Mwh,-\(%E5%9C%93%E6%9F%B1%E5%9E%8B26650](https://apogeepower.com.tw/#:~:text=100%E8%90%AC%E9%A1%86%E3%80%82-,%E5%B9%B4%E7%94%A2%E8%83%BD144Mwh,-(%E5%9C%93%E6%9F%B1%E5%9E%8B26650).
114. DSET interview with F.
115. 邱建齊, " 加百裕 BBU 直接切入 12kW，樣品拚 H2 開始出貨," January 2, 2026, <https://www.ttv.com.tw/finance/view/01202602115030E1F6E457C9489F8EC71D184877CB49392A/587>.
116. 邱建齊, " 新普無人機電池模組量產，冀明年有較顯著貢獻," MoneyDJ 理財網, November 18, 2025, <https://www.moneydj.com/kmdj/news/newsviewer.aspx?a=d2767286-83fe-490d-9efb-bb516ec77978>.
117. ibid
118. Ukraine custom data, available at <https://customs.gov.ua/en/statistika-ta-reiestri>
119. DSET interview with F.
120. 工商時報, " 台灣電池協會肩負打造無人機非紅供應鏈戰略使命," 工商時報, accessed May 13, 2026, <https://www.ctee.com.tw/news/20260513700361-431202>.
121. Chang Ping-feng, "Launch of the Drone and BBU Lithium Battery Module Alliance [無人機、BBU 鋰電池模組聯盟啟動]," Commercial Times, February 11, 2026, <https://www.ctee.com.tw/news/20260211700332-439901>.
122. DSET interview with A and C.
123. Etengoff, "How Do EV Battery Cell Charge and Discharge Rates Compare?"
124. Volta Foundation, 2025 Annual Battery Report (2026), <https://volta.foundation/battery-report-2025/>.
125. "The Economic Lessons from Ukraine's Spectacular Drone Success," The Economist, June 12, 2025, <https://www.economist.com/finance-and-economics/2025/06/12/the-economic-lessons-from-ukraines-spectacular-drone-success>.
126. Taiwan Battery Association, "Taiwan Battery Association Membership Directory."
127. Taiwan Battery Association, " 台灣電池產業鏈," accessed March 23, 2026, <http://www.taiwanbattery.org.tw/about/cluster>.
128. ATECOM, "ATECOM Product: NCM," accessed March 23, 2026, <https://www.atecom.com.tw/en/products/NCM>.
129. "About ATECOM," ATECOM, accessed March 23, 2026, <https://www.atecom.com.tw/en/about>.
130. "Battery Materials Products of CoreMax Corporation," CoreMax Corporation, accessed March 23, 2026, <https://www.coremaxcorp.com/en/battery-materials>.
131. Mechema Internation Group, "Mechema Products," accessed March 23, 2026, <https://www.mechema.com/29986216972638121209.html>.
132. DSET interview with A.
133. Public Procurement Commission, "The Public Construction Commission of the Executive Yuan has drafted the 'Unmanned Aerial Vehicle Procurement Operation Guidelines' for government agencies to reference when handling procurement for the acquisition or use of unmanned aerial vehicles," January 2026. <https://www.pcc.gov.tw/content/index?type=C&eid=10160&lang=1>
134. National Security Act (2022), <https://law.moj.gov.tw/ENG/LawClass/LawAll.aspx?pcode=A0030028>.

135. Defense Industry Development Act (2022), <https://law.moj.gov.tw/ENG/LawClass/LawAll.aspx?pcode=F0110024>.
136. Ministry of National Defense, " 中華民國國防部 114 年度下半年列管軍品清單 ," January 30, 2026, <https://www.mnd.gov.tw/information/services/publication/83260>.
137. Ministry of National Defense, " 中華民國國防部 114 年度下半年列管軍品清單 ."
138. Regulation (EU) 2023/1542 of the European Parliament and of the Council, 191 OJ L (2023), <http://data.europa.eu/eli/reg/2023/1542/oj>.
139. Regulation (EU) 2025/1561 of the European Parliament and of the Council, <https://eur-lex.europa.eu/eli/reg/2025/1561/oj/eng>.
140. Regulation (EU) 2024/1252 of the European Parliament and of the Council, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401252.
141. National Defense Authorization Act for Fiscal Year 2026, S.1071, Senate 119th (2025-2026) (2025), <https://www.congress.gov/bill/119th-congress/senate-bill/1071/text>.
142. "AS9100D : Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations," SAE International, September 19, 2016, <https://www.sae.org/standards/as9100d-quality-management-systems-requirements-aviation-space-defense-organizations>.
143. Intertek, "UN 38.3 Testing for Lithium Batteries," 2009, <https://www.intertek.com/batteries/un-38-3-testing/>.
144. International Electrotechnical Commission, "IEC 62660-3:2022," March 1, 2022, <https://webstore.iec.ch/en/publication/65084>.
145. "ALE | Advanced Lithium Battery Technology," American Lithium Energy Corporation, accessed April 28, 2026, <https://www.americanlithiumenergy.com>.
146. "Galvion: AS9100:2016 Certificate," Galvion, accessed April 28, 2026, <https://galvion.imagerelay.com/fl/4f98b602c1744f679bac73c1c23c8d60#>.
147. DSET interview with B.
148. Alessio Scanziani et al., "Designing an Effective Strategic Stockpiling System for Critical Minerals – Analysis," IEA, January 27, 2026, <https://www.iea.org/commentaries/designing-an-effective-strategic-stockpiling-system-for-critical-minerals>.
149. DSET interview with K
150. 尹洪京, "South Korean government is providing subsidies to Korean companies that produce key raw materials for batteries and chips", April 18, 2025. Yonhap News Agency. <https://cn.yna.co.kr/view/ACK20250418002700881>
151. "Republic of Poland Offers Ascend Elements Up to USD \$320 Million to Support Construction of Lithium-Ion Battery Materials Plant in Poland," Ascend Elements, May 7, 2025, <https://ascendelements.com/republic-of-poland-offers-ascend-elements-up-to-usd-320-million/>.
152. Ascend Elements, the U.S.-based battery materials company that received this grant offer, subsequently filed for Chapter 11 bankruptcy in April 2026 following the cancellation of a separate federal grant and broader EV market headwinds. The Polish facility had not broken ground at the time of filing. The episode underscores the financial fragility facing non-Chinese CAM producers during this build-out phase, but does not diminish the logic of the policy instrument itself. A sovereign grant structured around technology transfer and milestone-based disbursement retains value regardless of whether any single recipient survives; the more important question for Taiwan is which producers currently hold proven patents but lack the capital to reach commercial scale.
153. U.S. Department of War, "Joint Statement Reaffirming a Shared Commitment to Defense Industrial Resilience (Partnership for Indo-Pacific Industrial Resilience)," March 20, 2026, <https://www.war.gov/News/Releases/Release/Article/4439861/>.

154. 6K Energy, "U.S. Defense Logistics Agency Awards 6K Energy \$1.9M BattNet Phase III Cathode Active Material R&D Grant," December 15, 2025, <https://www.6kinc.com/news/press-release/the-united-states-defense-logistics-agency-awards-6k-energy-1-9m/>.

155. Michael Herh, "Korean Batteries Eye U.S. Defense Market," Businesskorea, March 13, 2026, <https://www.businesskorea.co.kr/news/articleView.html?idxno=265164>.

156. "Altilium and The Structural Battery Company Announce Collaboration to Develop UK Battery Supply Chain for Drones," Altilium, April 21, 2026, <https://altium.tech/2026/04/21/altium-and-the-structural-battery-company-announce-collaboration-to-develop-uk-battery-supply-chain-for-drones/>.

Powering Resistance

**Opportunities and Challenges in Localizing
Taiwan's Drone Battery Supply Chain**

