ENERGY TRANSITION PARTNERSHIP

Deliverable 3

Phase 1 Report: A review of global batteries' supply chain

UNOPS

AFD AGENCE FRANÇAISE DE DEVELOPPEMENT

Federal Ministry for Economic Affairs and Climate Action

Department for Energy Security & Net Zero

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Australian Government
Department of Climate Change, Energy, the Environment and Water

CIFF CHILDREN'S INVESTMENT FUND FOUNDATION

SEQUOIA CLIMATE FOUNDATION

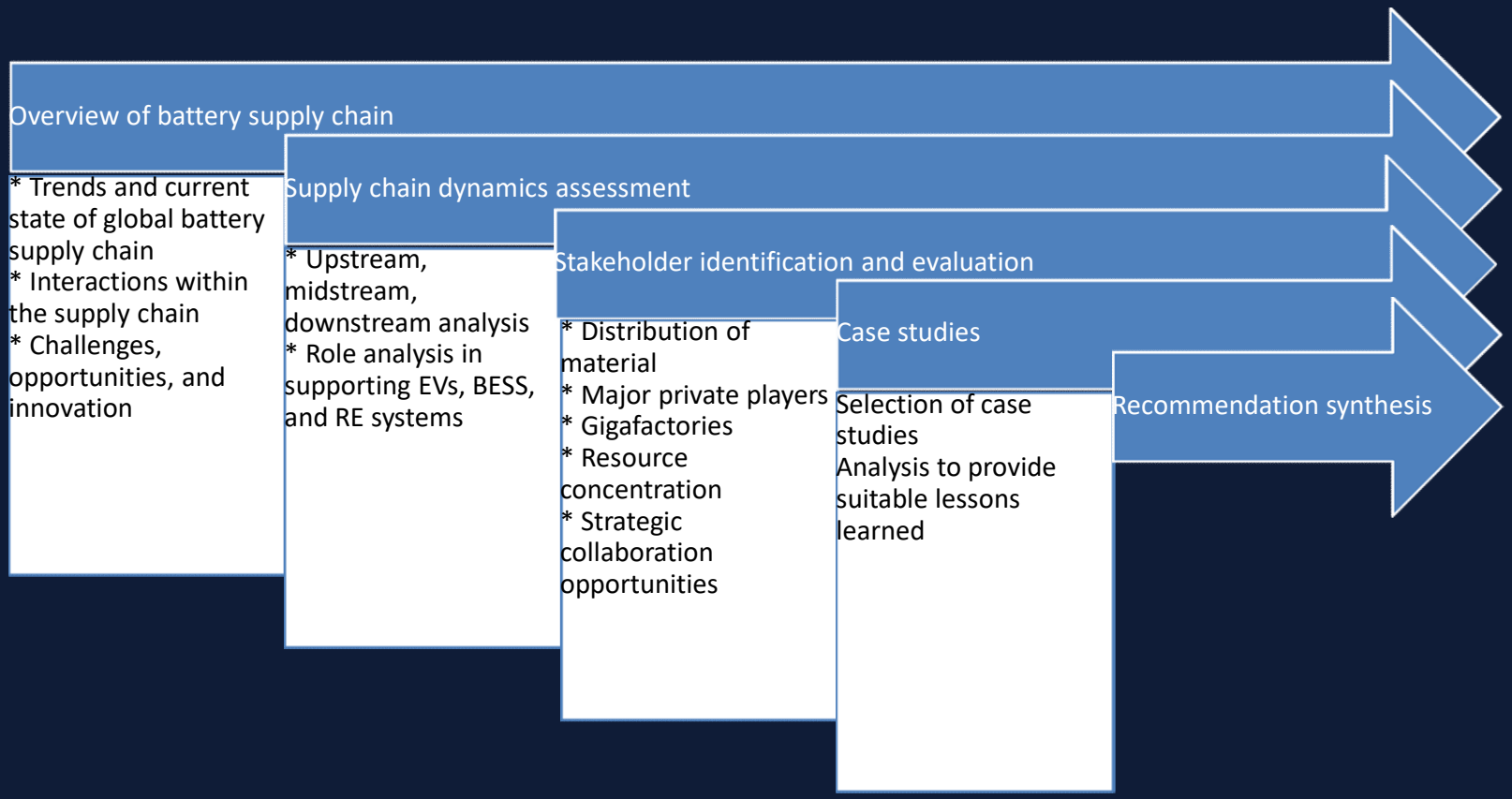
A review of global batteries' supply chain

This presentation outlines the crucial role of battery supply chain for energy transition, a comprehensive study of Vietnam's battery supply chain, focusing on electric vehicles (EVs), solar photovoltaics (PVs), and battery energy storage systems (BESS). We aim to identify gaps, justify investments, and propose strategies to strengthen the domestic supply chain and diversify supply sources.

Objectives

- **01** Role of global battery supply chain in the development and integration of EVs, BESS, and solar PVs
- **02** Provide a comprehensive assessment of the global battery supply chain.
- **03** Identify and evaluate key components, actors, and stakeholders within the supply chain
- **04** Provide suitable recommendations for Vietnam
- **05** Provide recommendations for optimising and leveraging the battery supply chain to drive investments in Viet Nam

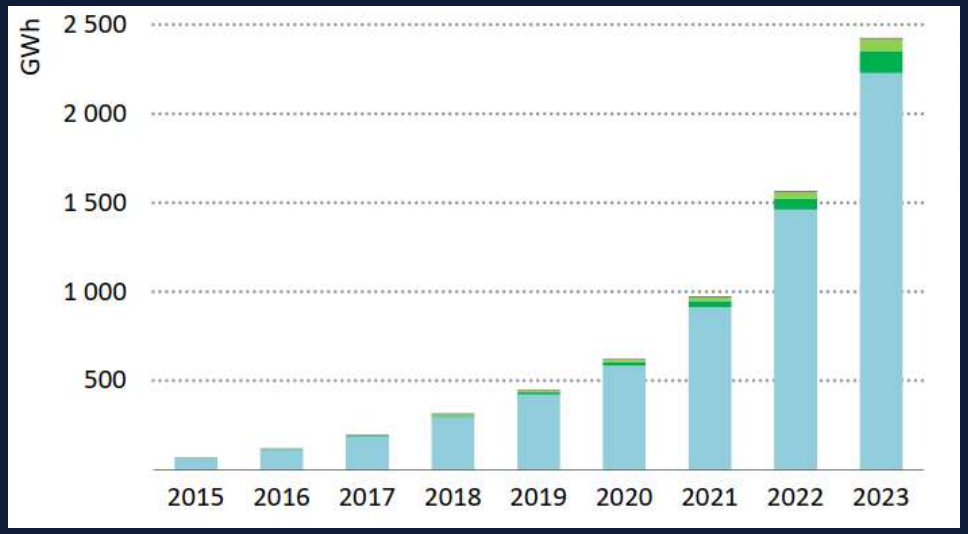
Overall approach



• The crucial role of battery supply chain for energy transition:

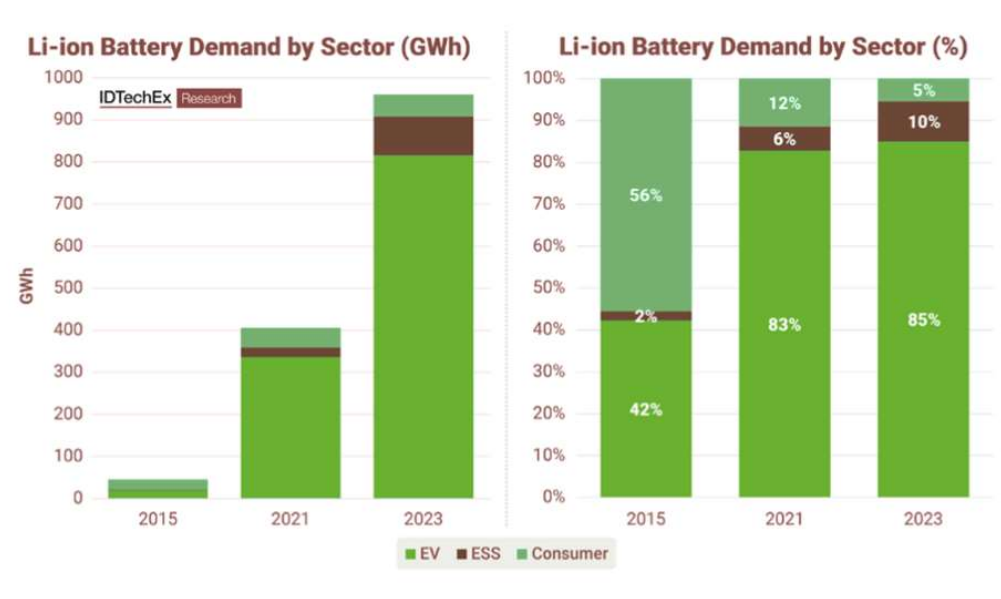
- Reduce carbon emission
- Reduce greenhouse gas emissions
- Combate climate change

Clean technologies:
- Electric vehicles (EVs)
- Battery energy storage systems (BESS)

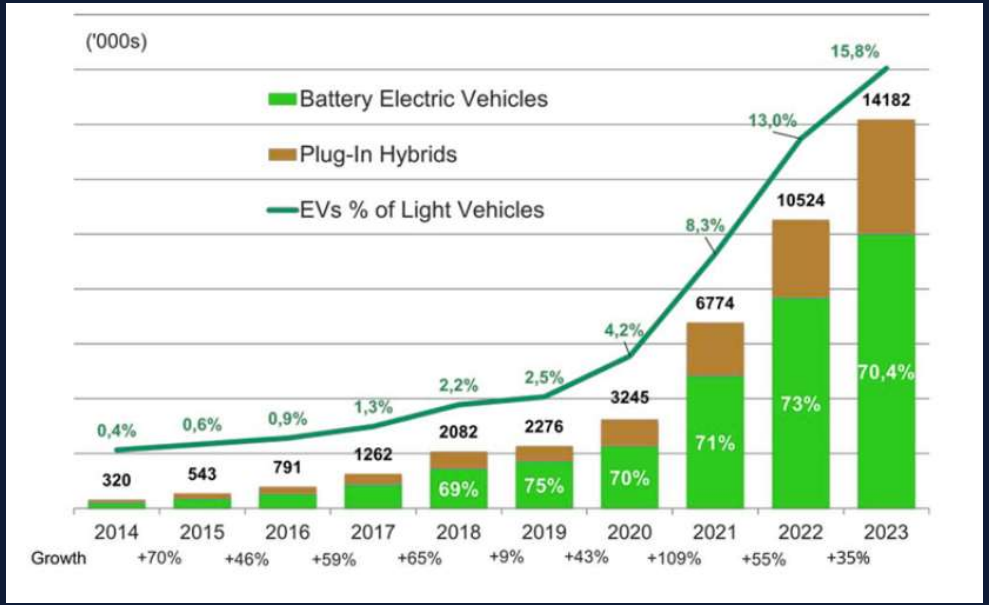


Lithium-ion battery volumes in use by type of application in the global energy sector, 2015-2023. Note: GWh=gigawatt-hours. Source: IEA.

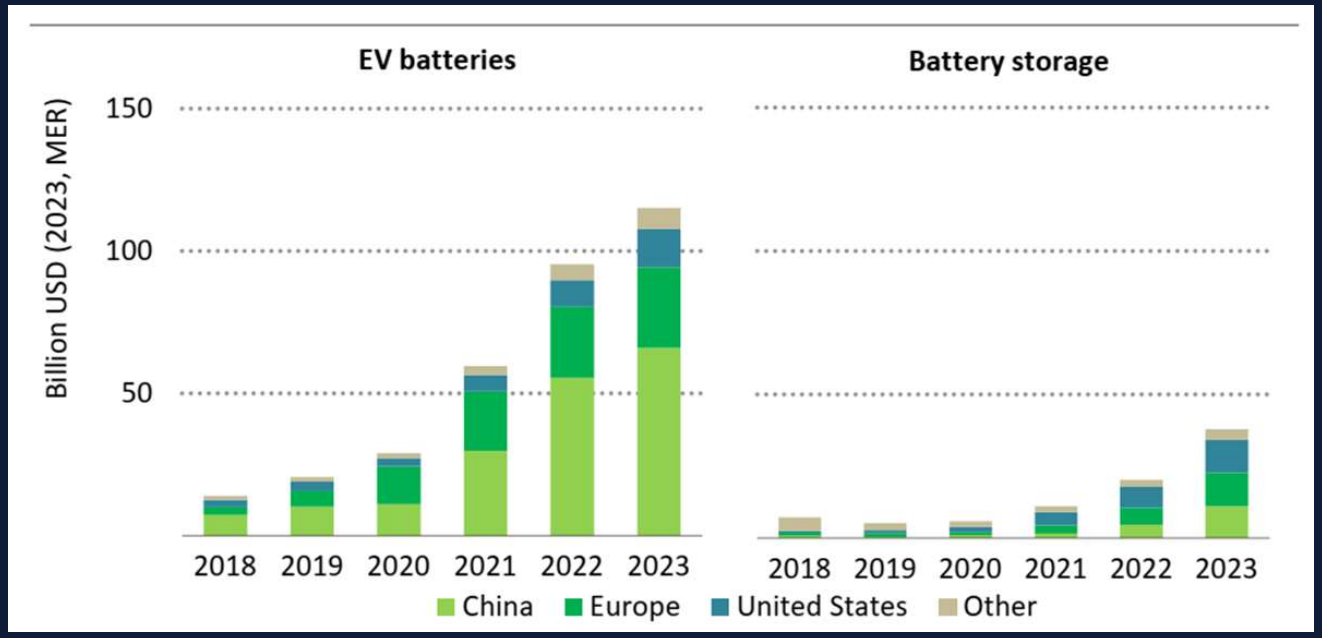
Li-ion battery demand by sector (GWh) (left) and (%) (right)



Global BEV & PHEV sales 2023

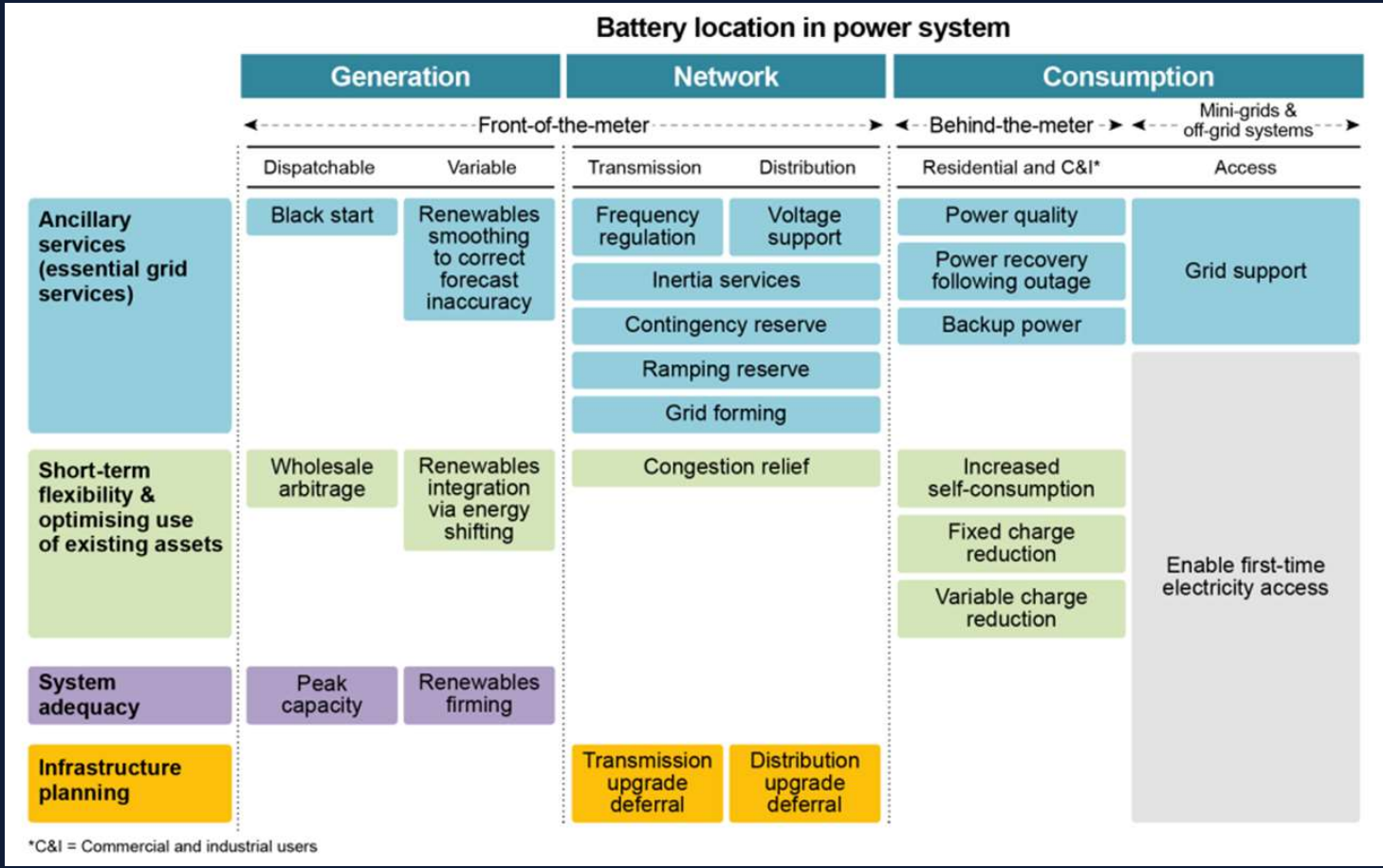


- Increasing investment in batteries, mainly for electric vehicle and battery energy storage sectors:



Investment in EV batteries and battery storage increased rapidly to USD 150 billion, with spending highly concentrated in China, Europe and the United States.

Source: IEA. Note: MER=market exchange rate.



Battery location in power system. Source: IEA, Adapted from Schmidt and Staffell (2023). Note: Battery storage applications are represented along the dimensions: horizontal axis shows the location within a power system; vertical axis shows the type of services

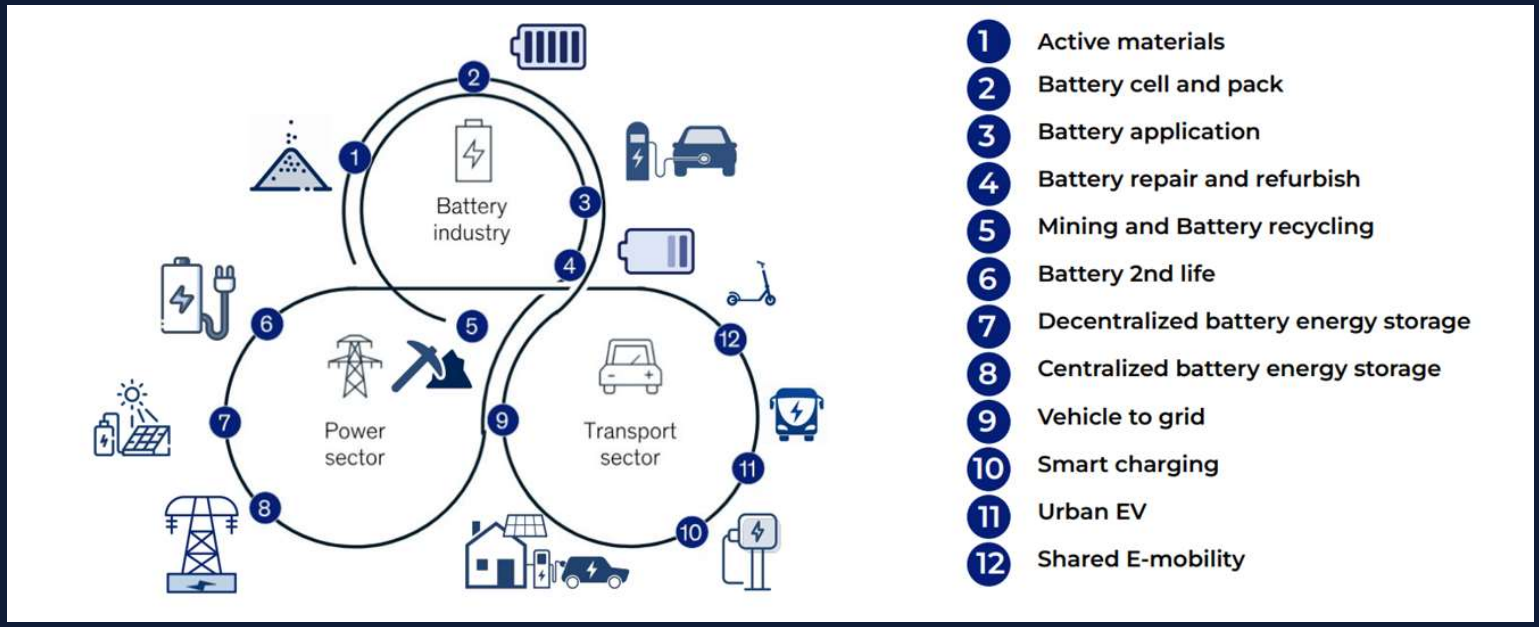
Battery metrics and best-fit applications for lithium-ion batteries

Application		Energy density	Cycle life	Cost	Charge rate	Safety
Electric vehicles	Passenger EVs					
	Commercial EVs					
	Electric buses					
	Two- and three-wheelers					
Stationary storage	Utility-scale					
	Commercial					
	Residential					

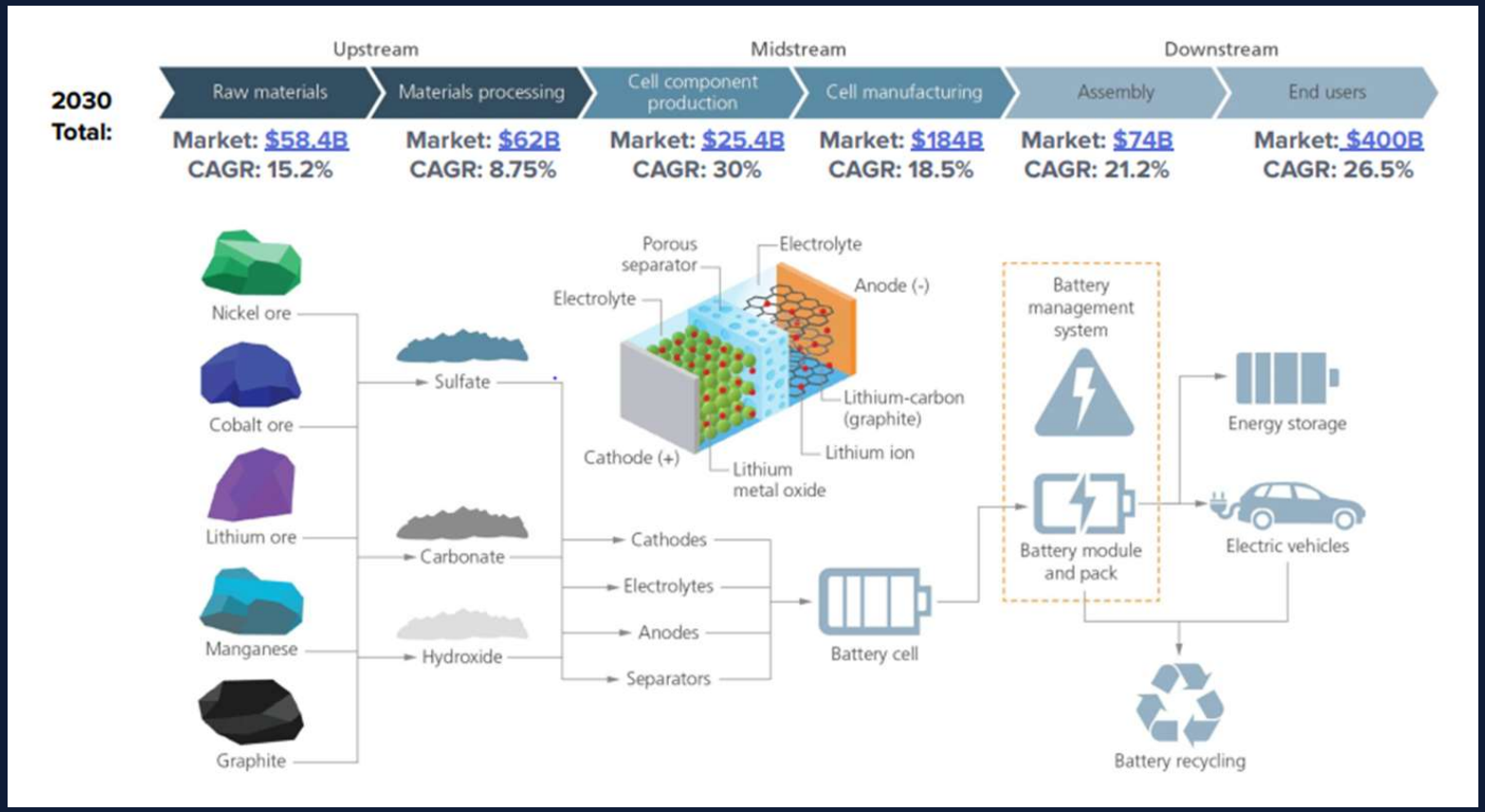
Source: BloombergNEF. Note: Green = most important metric, Yellow = less important metric, Grey = relatively unimportant metric

Comparison of battery metrics and best-fit applications for lithium-iron batteries between EVs and energy storage

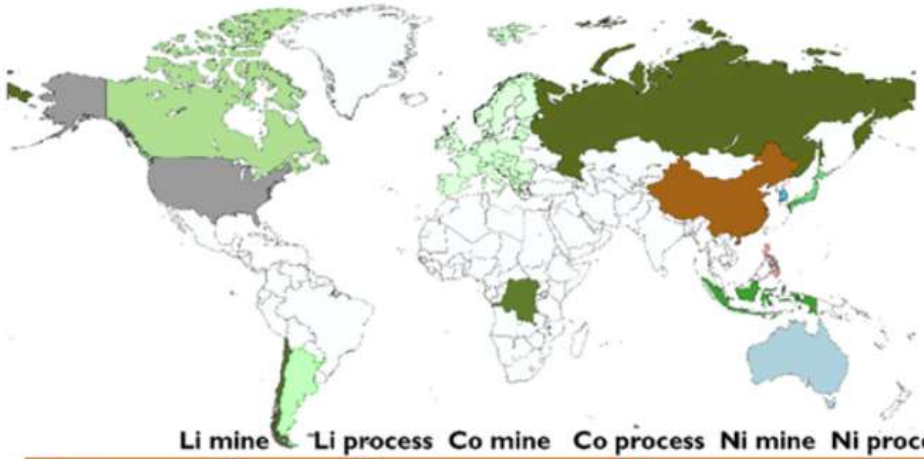
- Interactions within the supply chain:

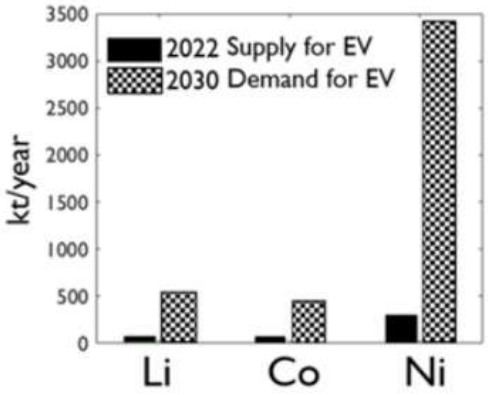


Global battery supply chain is expanding and opening up economic opportunities across different industries.
Source: Battery Report 2023.



Overview of the battery supply chain. Source: Battery Report 2023





	Li mine	Li process	Co mine	Co process	Ni mine	Ni process	Cathode	Cell	LDV sales
China	17%	65%	-	74%	-	17%	70%	76%	40,99%
Chile	26%	29%	-	-	-	-	-	-	0,55 %
Argentina	-	5%	-	-	-	-	-	-	0,45%
Canada	-	-	-	4%	-	-	-	-	0,45%
Indonesia	-	-	5%	-	49%	43%	-	-	1,36%
Russia	-	-	-	-	6%	5%	-	-	1,10%
Australia	47%	-	3%	-	-	-	-	-	1,35%
Congo	-	-	74%	-	-	-	-	-	-
Philippines	-	-	-	-	10%	-	-	-	0,39%
Japan	-	-	-	-	-	-	14%	4%	6%
South Korea	-	-	-	-	-	-	15%	5%	2,47%
Europe	-	-	-	10%	-	-	-	7%	21,99%
United States	-	-	-	-	-	-	-	8%	4,97%

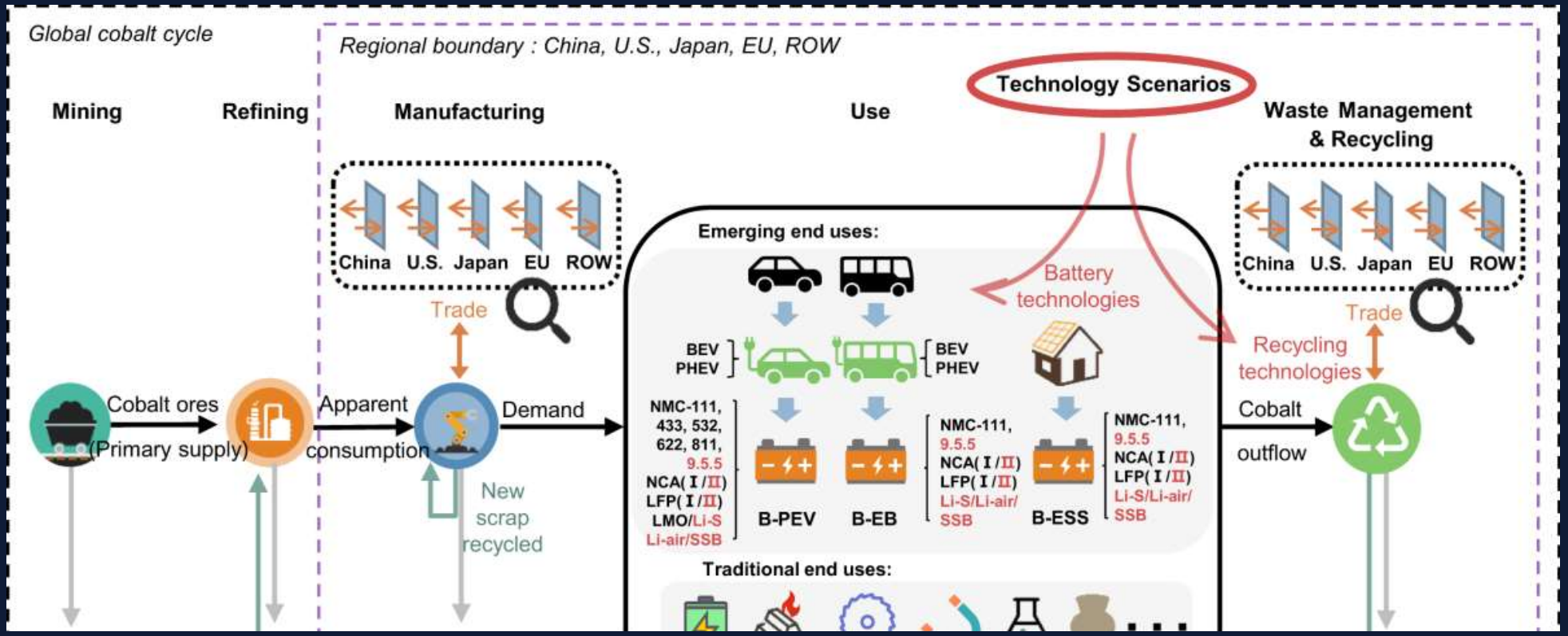
The geographic distribution of the lithium-ion battery value chain, along with the gap between supply in 2022 and projected demand in 2030 for Li, Co, and Ni under the NZE scenario (top right corner)

- Supply chain dynamics assessment
- Different battery technologies and their applications

LI-ION BATTERY CHEMISTRY	NOMINAL VOLTAGE (V)	CYCLE (LIFE)	CHARGE CURRENT RATE (C)	DISCHARGE CURRENT RATE (C)	THERMAL RUNAWAY (°C)	PACKAGING (TYPICAL)	SPECIFIC ENERGY (Wh/Kg)	APPLICATIONS	
Nickel Manganese Cobalt Oxide (NMC)	3.6 (3.0-4.2) range	1000+	0.7-1C	1-2C	210°C (410°F)	18650, 21700	150-220	E-Bikes, Medical Devices, EVs, Industrial	High Low
Lithium Iron Phosphate (LFP)	3.2 (2.5-3.65) range	2000+	1C	1C	270 °C (518°F)	18650, 32650, prismatic	90-120	Stationary Applications with high capacity, EV	Flat high safe
Lithium Nickel Cobalt Aluminium Oxide (NCA)	3.6 (3.0-4.2) range	500-1000	0.7C	1C	150 °C (302°F)	18650	200-260	Medical, Industrial, Electric Powertrain	Lon tem exp
Lithium Titanate Oxide (LTO)	2.4 (1.8-2.85) range	3000-7000	1C	10C	Highest	Prismatic	50-80	Electric Vehicle and Energy Storage Systems	High moc
Lithium Cobalt Oxide (LCO)	3.6 (3.0-4.2) range	500-1000	0.7- 1C	1C	150 °C (302°F)	18650 Prismatic & pouch cell	150-200	Laptops, Mobile Phones, Tablets, Cameras	High
Lithium Manganese Oxide (LMO)	3.7 (3.0-4.2) range	300-700	0.7-1C	1C	250 °C (482 °F)	Prismatic	100-150	Medical Devices, Electric Powertrains, Power Tools	High safe

- Supply chain dynamics assessment

- Role analysis of the battery supply chain in supporting the e-mobility and renewables sectors

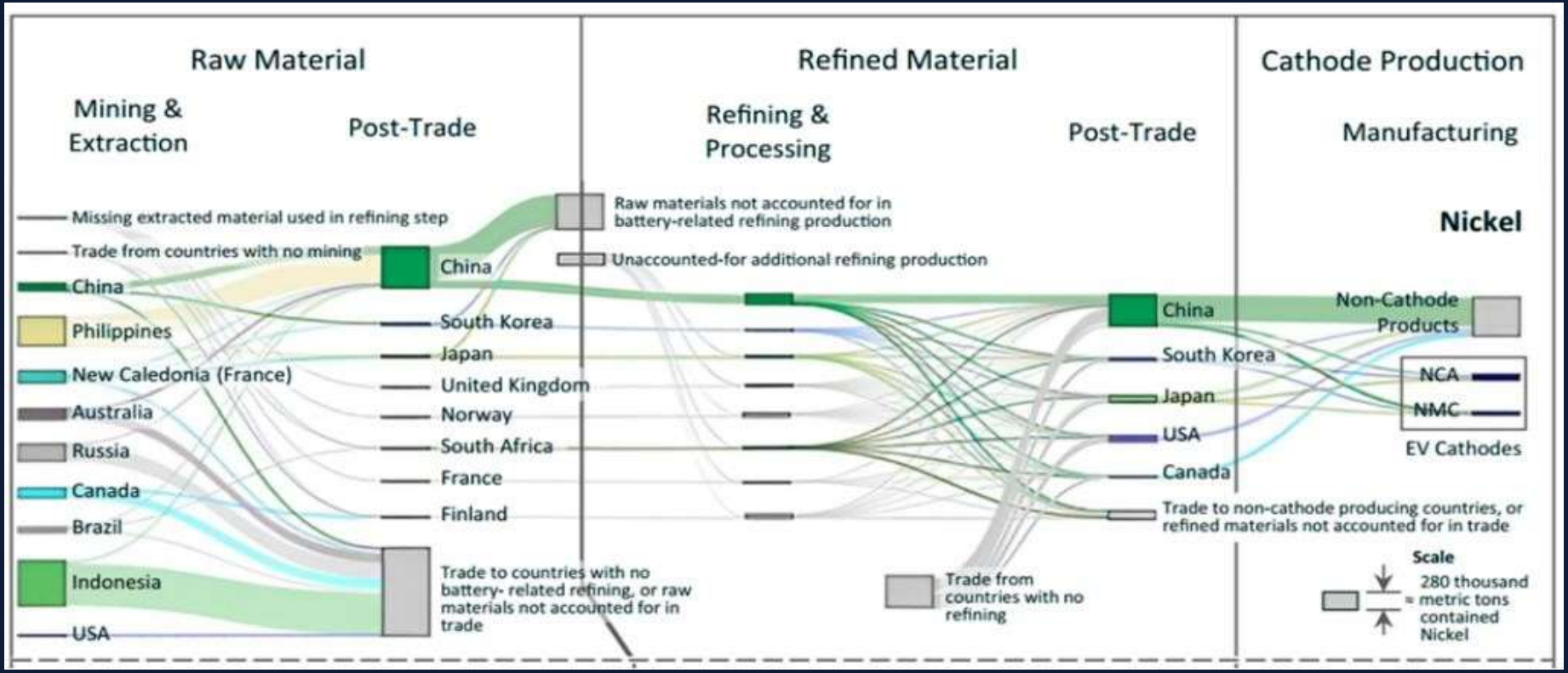


- Stakeholder identification and evaluation
- Stakeholder mapping

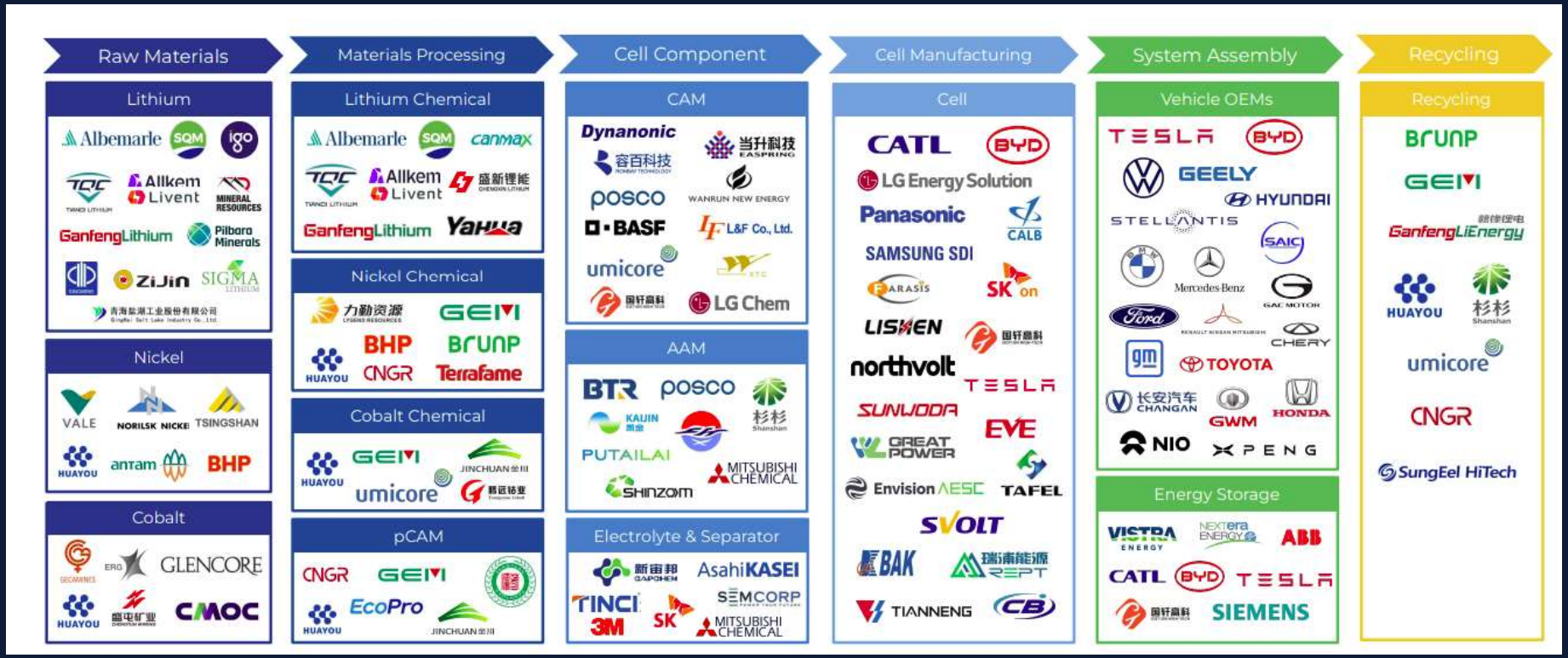
mineral/ton lithium metallic equivalent		
	Domestic production	**Import**
	6,300	0
	45,000	0
	2,400	0
	200	0
	19,300	0
	10,800	48,023
	900	0
	1,380	295

Nickel ore/ton nickel metallic equivalent		
Country	**Domestic production**	**Import**
Albania	5,520	0
Australia	159,000	0
Austria	0	1
Belgium	0	31
Botswana	15,195	0
Brazil	60,600	7
Canada	181,000	0
China	120,000	841,743
Colombia	36,564	0
Cuba	49,200	0

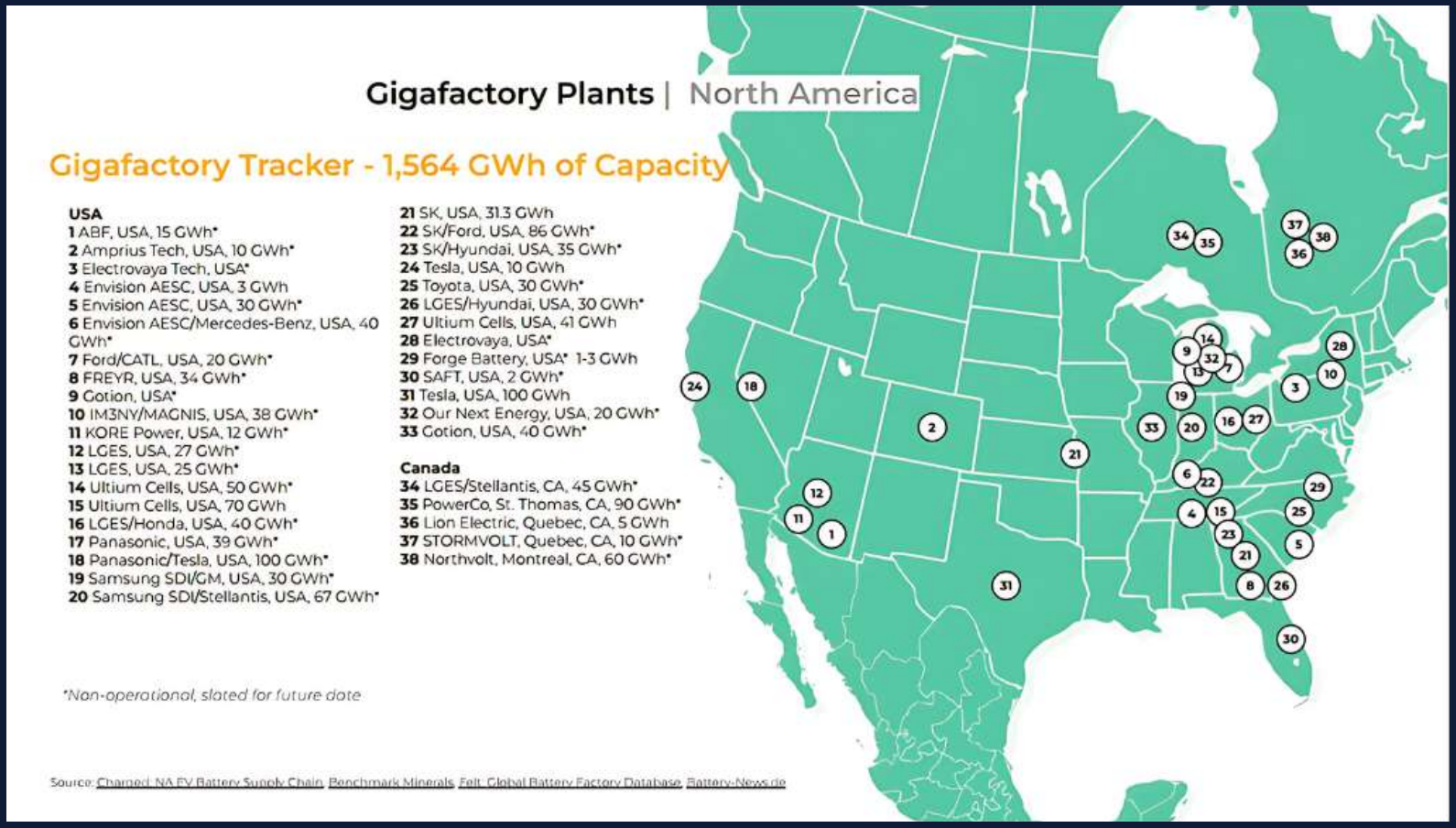
- Stakeholder identification and evaluation
- Stakeholder mapping



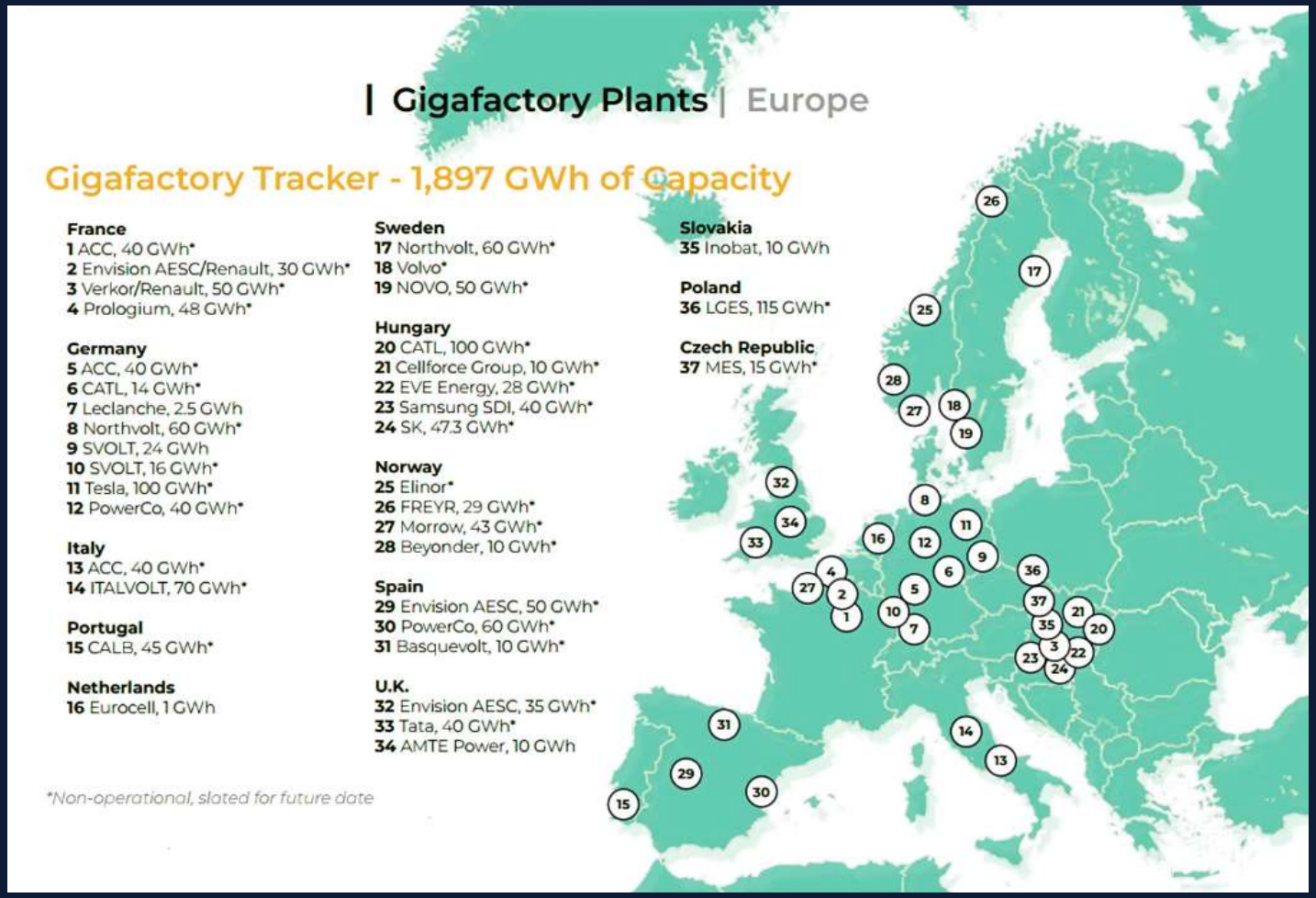
- Stakeholder identification and evaluation
- Major private players in the battery supply chain



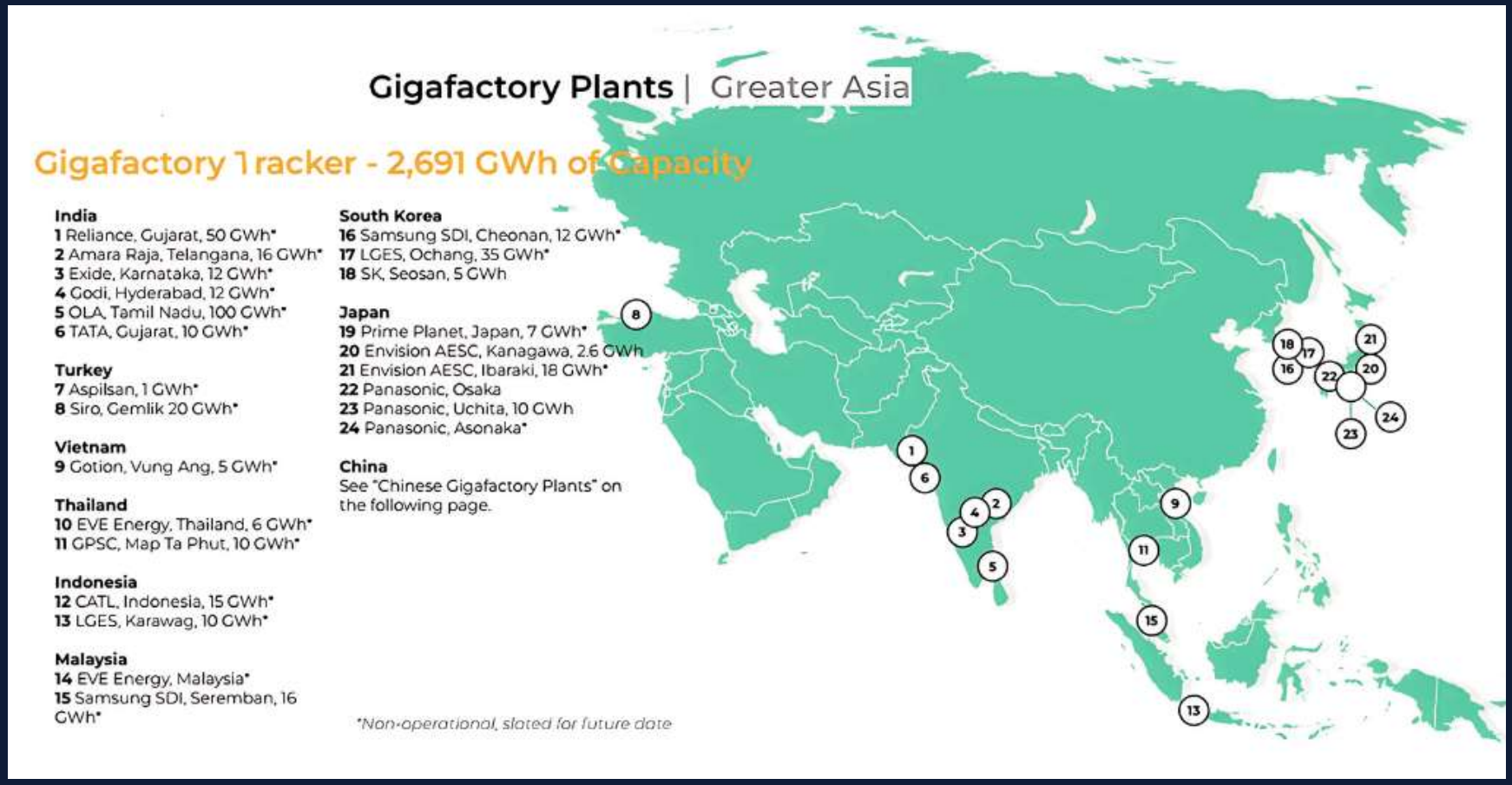
- Stakeholder identification and evaluation
- Gigafactory plants in North America



- Stakeholder identification and evaluation
- Gigafactory plants in Europe

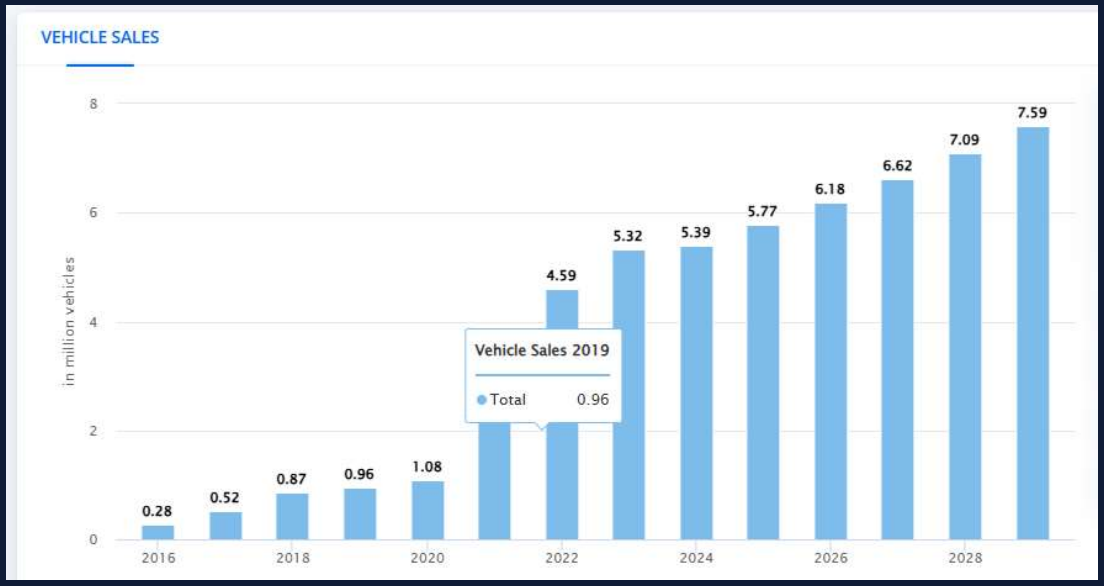


- Stakeholder identification and evaluation
- Gigafactory plants in Greater Asia

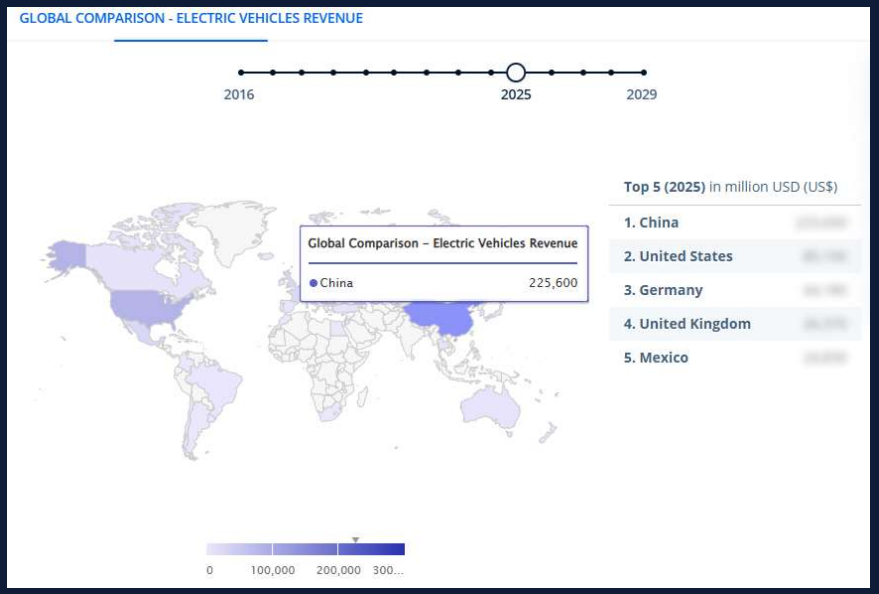


Vietnamese Companies in the Battery Supply Chain

- Case Studies
  - China:

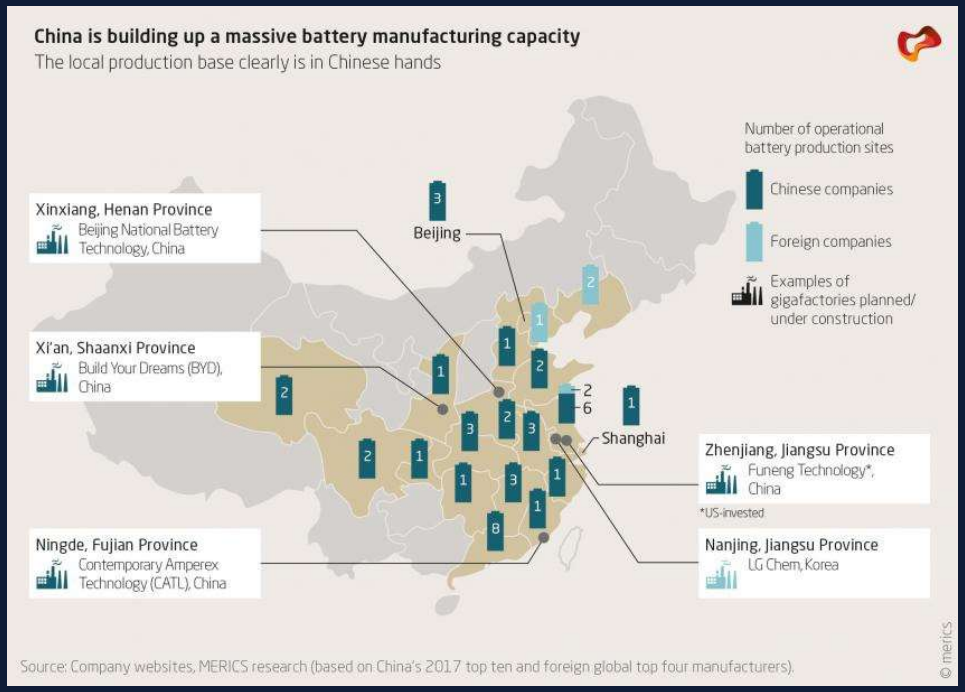


China car sales. Source: Statista Market Insight



Compare electric vehicle sales worldwide

- Case Studies
  - China:



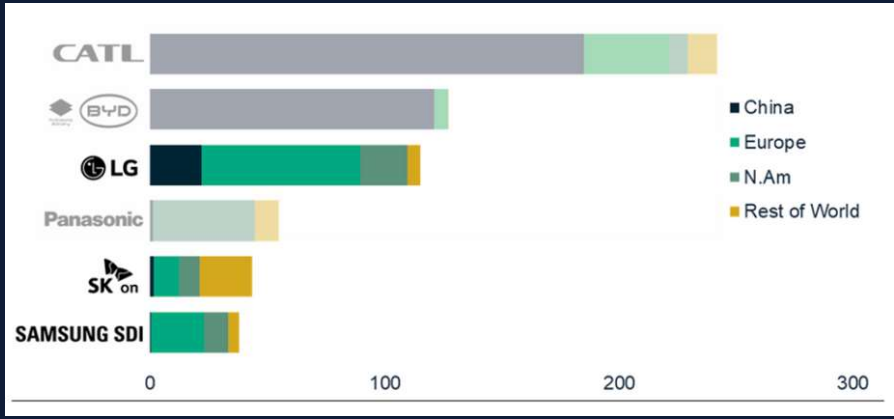
China's global share of the lithium supply chain

Key insights for Vietnam's Supply Chain

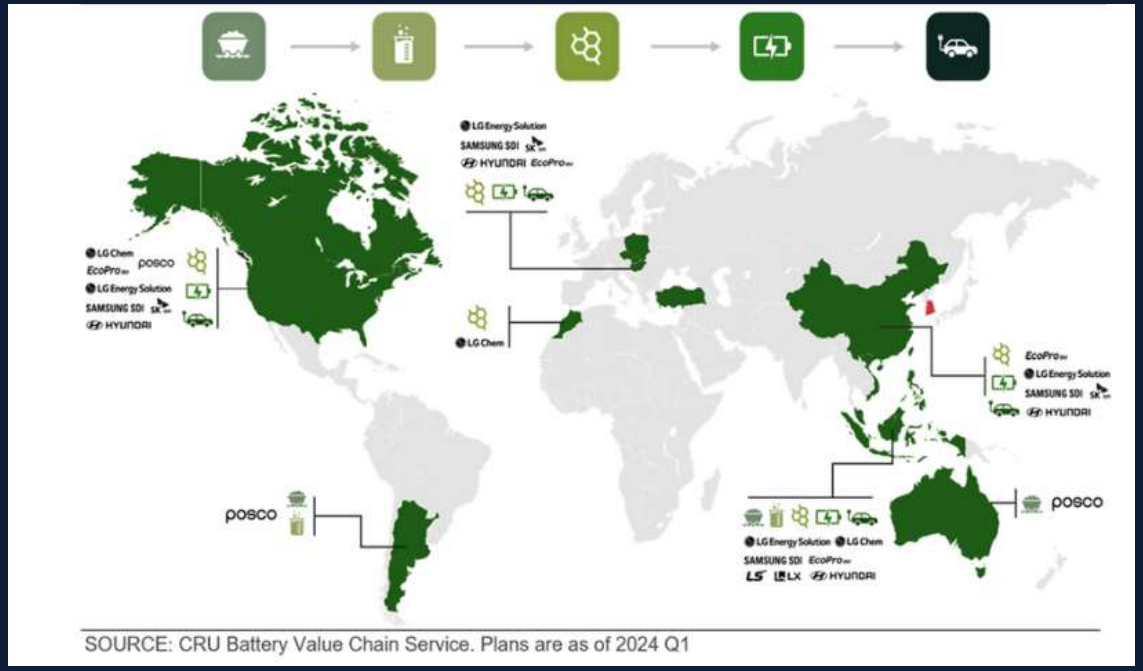
As Vietnam aims to become a regional hub for EV manufacturing and renewable energy storage, with companies like VinFast leading the charge, China's model provides actionable strategies to build a competitive and sustainable battery ecosystem.

	China's experience and key insights	Potential application in Vietnam
Contextual relevance	- Close geographic proximity, sharing a 1,281 km border. This can reduce logistics costs via cross-border economic corridors (e.g., Nanning-Hanoi Economic Corridor). - Commitments and targets linked to EVs and BESS. - China exports and pours FDI into Vietnam - Both are participants in the Regional Comprehensive Economic Partnership (RCEP)	
Investment focus	***Upstream***: sourcing domestic reserves and strengthen alliances through interdependencies ***Midstream***: expanding refining, focusing on lithium hydroxide and nickel sulfate refining; support for gigafactories ***Downstream***: strong BESS and EV industries, creating demand for batteries ***Exports and FDI***: BRI projects and projects worldwide	Strengthen the exploration of domestic reserves while establishing partnerships to secure further resources. Enhance domestic manufacturing policies
Overarching policy framework	FYPs (e.g., 14th FYP: €50B for 2,500 GWh) and protectionist, state-led Made in China 2025 (40 GWh target) drive structured growth	Embed goals and targets linked to battery production generally and LIB particularly in economic development plans.
Subsidies/ incentives	€20B subsidies, €2B tax exemptions, €10B loans since 2020; reduces costs by 15-20%	Enhance subsidies, taxes, and other incentives linked to EV and LIB. Establish preferential policies for BESS in the long run. Build national champions, and inspire startups/ private companies to partaking in the sphere.
R&D funding	€10B annually, 500 patents (2024), 15 innovation parks (50,000 jobs); 30% solid-state patents	Provide further investment in R&D. Focus on establishing industrial parks with a focus on battery production. Build tech capabilities.
Recycling mandate	70% recovery by 2025, €1B infrastructure; 90% lithium recovery (100,000 tons/year)	Focus on enhancing recycling practices and research on potential policies on recycling.

- South Korea:

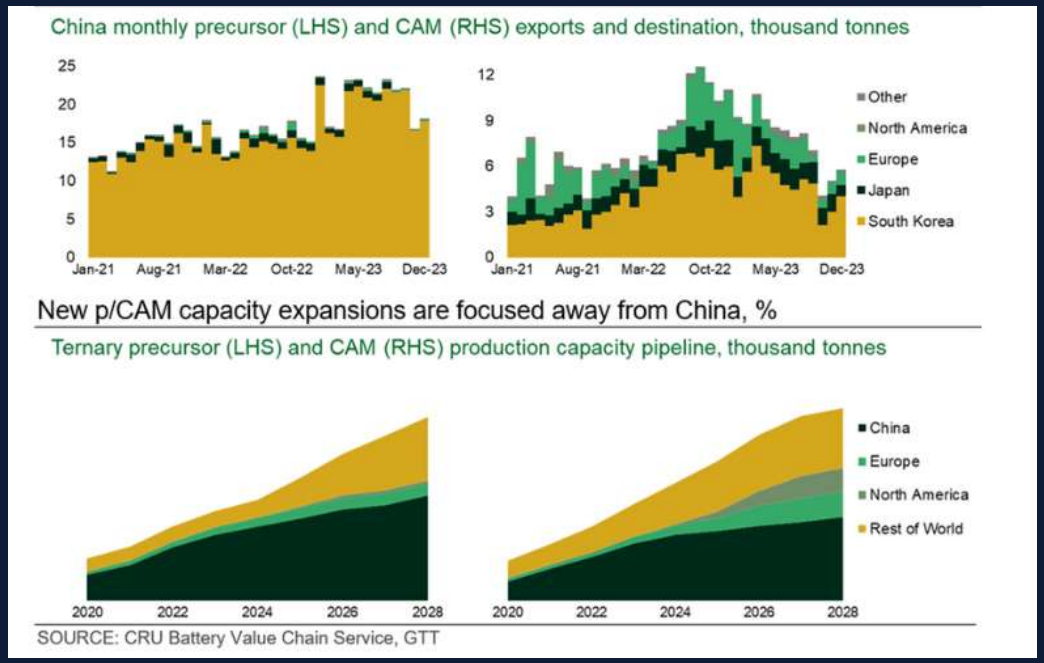


Top 6 rankings by battery deployment in 2023, in GWh. LG, SK On, and Samsung SDI are major global actors. Adapted from CRU Value Chain Service

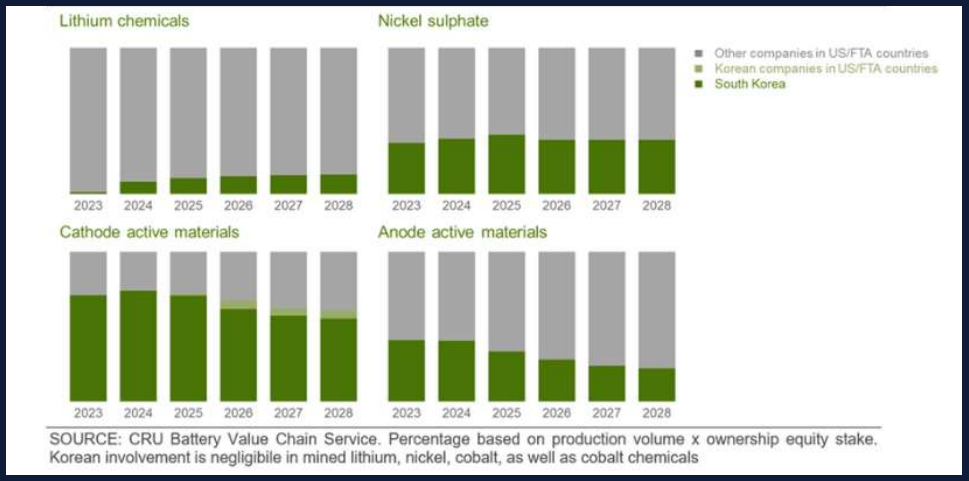


The overseas production plans of major companies originating from South Korea

- South Korea:



South Korea's export of precursors and cathodes is expected to level off or decrease in 2023 as the country becomes self-sufficient



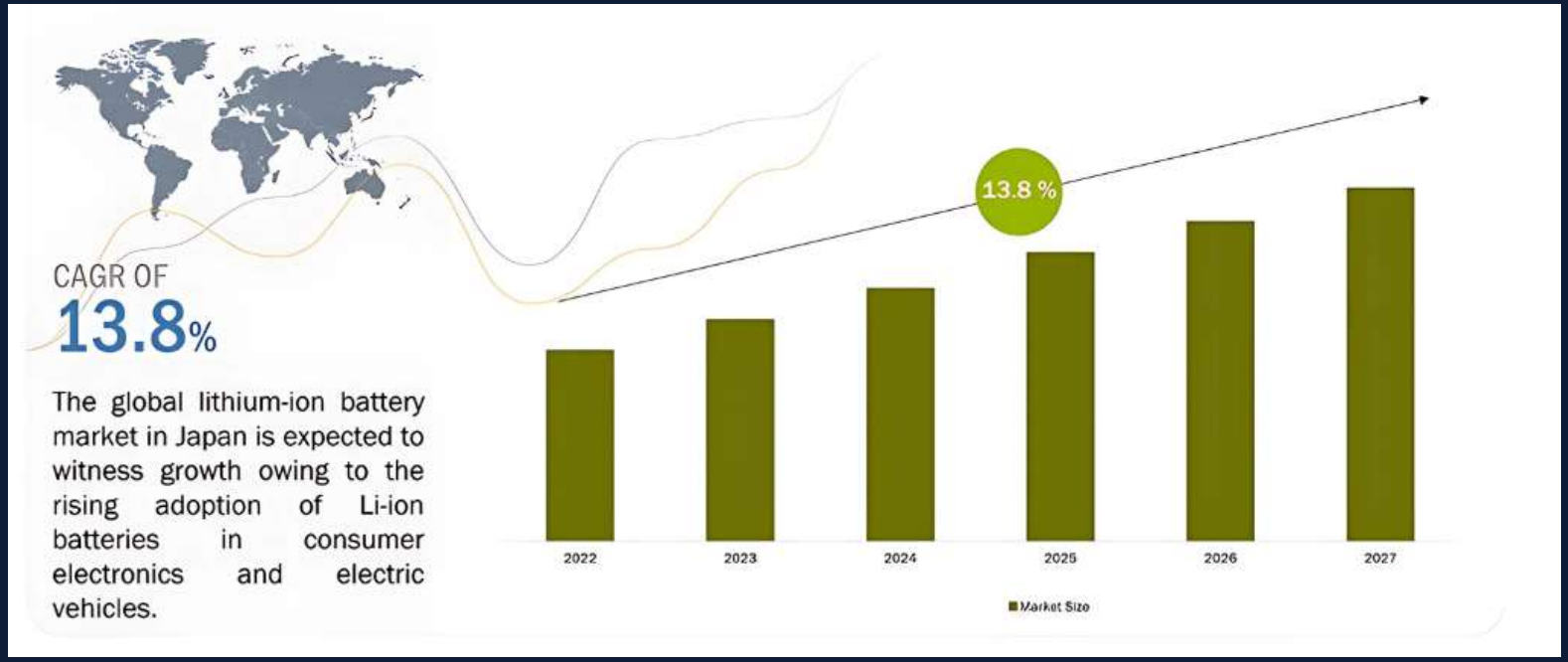
South Korea's ownership in the IRA-compliant supply chain

Key insights for Vietnam's Supply Chain

Given the existing trade relations between the two countries and South Korean companies' strong presence in Vietnam, leveraging South Korea's investment focus, policy frameworks, and incentives can accelerate Vietnam's battery industry growth. To enhance competitiveness, targeted subsidies, national recycling policies, and large-scale R&D programs will be crucial. Establishing joint ventures with South Korean firms can facilitate technology transfer, positioning Vietnam as a regional leader in battery production and export.

	Insights	
Contextual relevance	- South Korea is Vietnam's third-largest trade partner and second-largest import market. The total trade volume between South Korea and Vietnam increased by 9.2%, rising from $79.4 billion in 2023 to $86.7 billion in 2024. - Main export products from South Korea to Vietnam were electrical, electronic equipment, vehicles, etc. - Samsung SDI and LG Chemical have strong investment and presence in Vietnam, with intention for battery production. However, the lack of priority policies for investment in battery supply chain has hindered the actual investment.	
Investment focus	***Upstream***: heavily reliant on mineral imports, so exploring partnerships with resourceful countries (e.g., Australia, cathode share. Support for gigafactories. ***Downstream***: increasing demand from other sectors. ***Exports and FDI***: Focus on global market, with expansion into North America and Europe.	Enhance bilateral agreements to promote battery trade and technology exchange.
Overarching policy framework	Green New Deal, K-Battery Strategy	Integrate further focus on battery supply chain development into Vietnam's Green Growth Strategy (GGS); consider dedicated strategies for developing battery supply chain
Subsidies/ incentives	Strong investment to strengthen EV battery supply chain, focusing on diversifying away from reliance on China and aligning with US tax credit rules, including cheaper state loans and tax incentives.	Introduce priority policies for battery investment to attract South Korean manufacturers; developing a Battery Investment Package with production-linked incentives, tax breaks, and low-interest loans; establish joint venture incentives between domestic and foreign battery firms for technology transfer.
R&D funding mandate	Large-scale R&D program in the form of public-private partnership as KS C IEC 62660-1/2/3 and KS C 62133; Korean Motor Vehicle Safety Standards; environmental standards (KECO focusing on battery recycling and disposal regulations; EEEV on collection and recycling of batteries and other vehicles components), etc.	Establish a network with universities, research institutes, and industry standards on recycling of batteries; developing further studies and policies focusing on recycling; invest in battery recycling infrastructure and incentivize private sector participation.
Sectoral policies	Promoting public and private demands for rechargeable battery; providing financial aid for local electric-car battery makers	Implement financial incentives for battery manufacturers to localize production; promote battery adoption in public transportation to drive

- Japan:



Lithium-ion battery market forcast to 2031 in Japan (USD million)

The lithium iron phosphate battery market, by capacity, 2017-2022 (million USD)

Capacity (mAh)	2017	2018	2019	2020	2021	2022	Annual Growth Rate (CAGR) (2017-2022)
0-16,250 mAh	23	25	26	22	34	44	14.0%
16,251-50,000 mAh	42	46	47	39	63	81	14.3%
50,001-100,000 mAh	45	50	52	43	67	87	14.1%
100,001-540,000 mAh	72	79	83	69	107	138	14.0%
Total	182	200	208	173	272	351	14.1%

Lithium Iron Phosphate Battery Market by Capacity, 2017-2022 (in million USD)

Industry	2017	2018	2019	2020	2021	2022	Annual Growth Rate (CAGR) (2017-2022)
Automotive	25.8	29.8	32.6	37.8	121.2	170.6	45.9%
Energy	44.6	48.5	50.0	37.5	40.8	48.3	1.6%
Industrial	48.7	54.4	57.6	45.3	51.4	62.5	5.1%
Consumer Electronics	1.9	2.2	2.4	2.1	3.5	4.7	19.8%
Aerospace	27.9	30.2	31.0	23.6	26.1	30.8	2.0%
Maritime	24.6	26.4	26.9	20.4	22.3	25.9	1.1%
Other Industries	8.0	8.3	7.9	6.2	6.3	8.2	0.5%

Key insights for Vietnam's Supply Chain

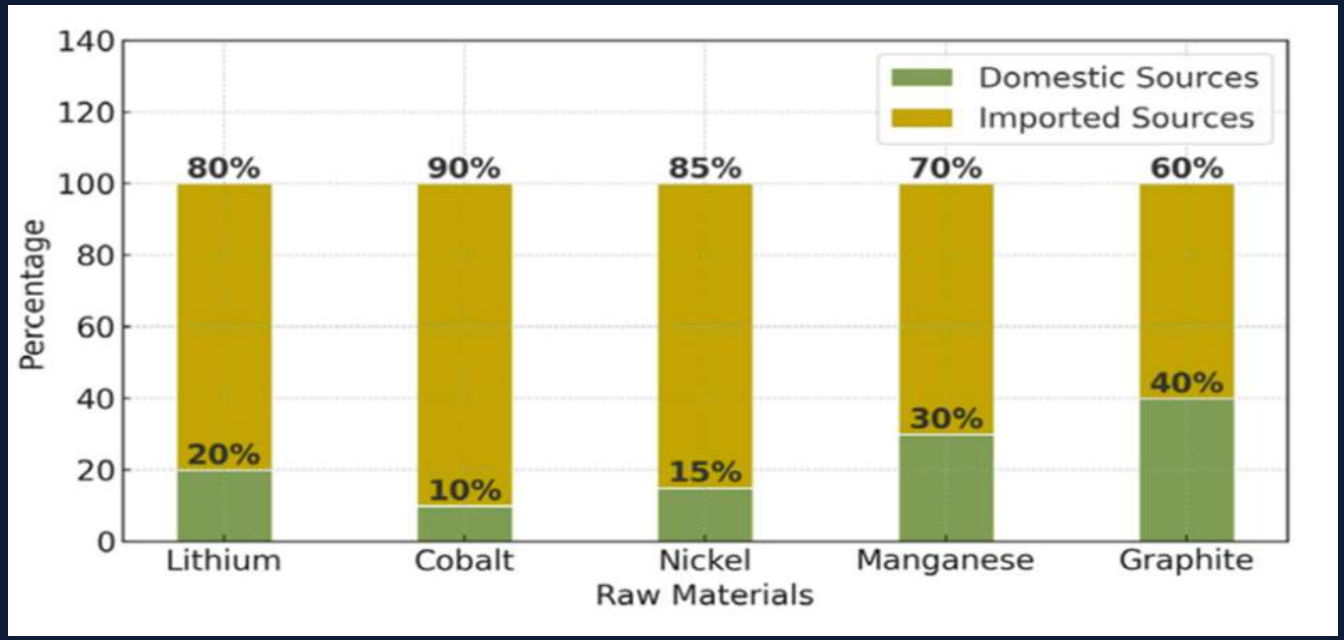
Japan’s strong emphasis on research and development, recycling, and end-of-life battery processing aligns with Vietnam’s current drive for technological breakthroughs and innovation, offering valuable best practices. Given the strategic Japan-Vietnam partnership, deeper collaboration in battery technology and supply chain development presents a promising opportunity. However, adopting Japan’s model in Vietnam will require substantial investments in infrastructure, advanced technologies, and workforce training, alongside robust government policies to support an efficient and sustainable battery ecosystem.

- Australia:

Strong government support, strategic policy development, regulatory incentives, strategic use of resources, and ESG emphasis

	Australia's experience and key insights	Potential application in Vietnam
Contextual relevance	- Both countries are in the Asia-Pacific region and have a strong trade and investment relationship through the Enhanced Economic Engagement Strategy (2019) and Comprehensive Strategic Partnership. - Australia is a resource-rich country with extensive experience in battery supply chain development and significant investments in critical minerals and battery technologies. Cooper's $2.2 project located in the Son La Province of Vietnam, which includes an existing modern nickel mine built to Australian standards.	
Investment focus	***Upstream***: Strong expertise in mineral extraction and refining; ***Midstream***: Heavy focus on lithium-ion, sodium-ion, vanadium flow batteries, super anode, future electrolyte systems, cathode active materials ***Downstream***: Increasing demand from sectors like energy storage and EVs ***Exports and FDI***: investment in countries with potential	Strengthen bilateral cooperation by expanding government-to-government (G2G) agreements on battery supply chain development. Develop technology-sharing partnerships with Australian firms for responsible mining and refining practices. Facilitate joint ventures between Vietnamese enterprises and Australian battery companies.
Overarching policy framework	The 2024 National Battery Strategy is the cornerstone policy, supported by the Future Made in Australia program Complementary policies include the 2021 Modern Manufacturing Strategy, 2022 Low Emissions Technology Statement, 2020 Global Resources Strategy, 2023 Australian Critical Minerals Strategy, 2021 Technology Investment Roadmap, 2023 Critical Minerals Strategy	Develop a cohesive strategy for battery supply chain development or innovative technological breakthroughs Align investment policies across the energy, industry, and finance sectors to ensure coordinated support. Integrate critical minerals strategy into the broader national green industrialization plan.
Subsidies/ incentives	AUD 532.2 million (USD 356.6 million) for the Battery Breakthrough Initiative and AUD 7 billion (USD 4.7 billion) in tax credits from 2033–34 for critical minerals processing	Introduce an innovation fund to provide targeted financial incentives for battery production and technology R&D. Implement preferential tax rates and low-interest loans to attract private
&D funding	AUD 20.3 million (USD 13.6 million) for Future Battery Capacity Building and over AUD 1.8 billion (USD 1.21 billion) by ARENA since 2012 for renewable energy and battery R&D. Support to deliver the Australian Made Battery Precinct	Establish industrial parks dedicated t battery manufacturing, similar t Australia's Battery Precinct. Increase government grants an public-private partnerships (PPPs) fo advanced battery R&D Incentivize university/researc institute-industry collaboration fo battery technology advancements.
ecycling andate	Targets 80% material recovery from batteries by 2030, supported by the Battery Stewardship Council and	Invest in modern battery recyclin infrastructure to reduce dependenc on raw material extraction.
	Association for the Battery Recycling Industry	
Sectoral policies	Committing to 100% new passenger vehicle sales as clean energy vehicles by 2035 Supports energy storage with 5 GWh grid integration by 2030 and community batteries (400 units, AUD 224.3 million).	Strengthen Vietnam's EV adoptio strategy with further investmen incentives. Develop strategies/ incentives fo BESS

- India:



Raw materials for battery production in India (2023)

Key insights for Vietnam's Supply Chain

India is an emerging player in the battery supply chain, having started its development earlier than Vietnam. Its lessons learned offer valuable insights. India's USD 1.2 billion investment in lithium extraction has helped reduce import dependence, providing Vietnam with a model for developing domestic reserves through nationwide surveys and modern mining infrastructure. Strong policies like India's NMTMBS and PLI-ACC, which have attracted USD 5.4 billion in investments, underscore the need for clear targets and financial incentives in Vietnam. India's gigafactory expansion and skilled workforce strategy highlight the importance of investing in manufacturing plants and workforce training to lower production costs. Furthermore, India's approach to international collaboration and R&D—through global partnerships and sustained annual R&D investments—demonstrates the opportunity for Vietnam to establish innovation hubs, strengthen global cooperation, and expand the National Innovation Center's focus on battery technology.

	India's experience and key insights	Potential application in Vietnam
Contextual relevance	- Strong trade relations, with bilateral trade turnover reaching approximately US$15 billion in 2024, an increase of 4.5% in comparison to 2023 - Extensive economic ties, reflected by the Comprehensive Strategic Partnership - Aligned focus on sector like automotive, manufacturing, etc.	
Investment focus	***Upstream***: exploring and exploiting domestic reserves and forming partnerships ***Midstream***: Nascent stage of manufacturing, support for gigafactories ***Downstream***: creating demand from other sectors, particularly EV ***Exports and FDI***: Focus on ASEAN and countries with strong reserves or capacities	Currently, Vietnam has the potential to mine some important minerals; however, there is no comprehensive strategy in place to exploit and effectively use these resources. Vietnam can apply a similar approach by conducting nationwide surveys for strategic minerals, focusing on high-potential areas. At the same time, building modern mining and processing infrastructures will help optimize the value of resources.
Overarching policy framework	NMTMBS targets 50 GWh by 2026, 100 GWh by 2030	Embed goals and targets linked to battery production generally and LIB particularly in economic development plans.
Subsidies/ incentives	PLI-ACC (USD 2.5B), FAME (USD 1.2B)	Enhance subsidies and tax incentives for EV and LIB production
R&D funding	€10B annually, 500 patents (2024), 15 innovation parks (50,000 jobs); 30% solid-state patents	Invest in R&D, establish industrial parks with a focus on battery tech, train workers. Potentially expand the scope of National Innovation Center (NIC) to include battery technologies and development.
Recycling mandate	70% recovery by 2025, USD 500M infrastructure	Establish programs on recycling
Sectoral policies	Increase support for BESS sectors through ESO and VGF, EV policies with incentives	Decision 876/QD-TTg linked to decarbonization the transport sector, with goals for EVs. There have been certain incentives for EVs also.

Conclusion and Next Steps

Country	Global Market Position	Raw Material Access	Production Capacity	Government Policy Support	Innovation & Technology	Challenges
China	Dominates (70-90% of supply chain stages)	Controls 80% of global refining via overseas acquisitions	77% of global cell capacity; leaders with CATL, BYD	Large subsidies ($230 billion, 2009-2023), national champions, export restrictions, R&D funding	Strong in LFP; aiming for solid-state batteries by 2027	Overcapacity, environmental concerns, geopolitical tensions
Japan	Strong but declining	Dependent on imports; has refining capacity	Significant but declining (e.g., Panasonic)	Industrial strategy for 150 GWh domestic by 2030, R&D incentives	Leading in NMC, aiming for solid-state batteries by 2028	Losing position to China, high costs
South Korea	Competitive but behind China	Dependent on imports; strong in intermediate inputs	37% market share (LG Chem, Samsung SDI, SK On)	Support for EV battery centers, joint ventures (e.g., SK with Ford), focus on R&D	Progressing in NMC, aiming for solid-state batteries by 2027	Dependence on China for inputs, shrinking market share
India	Emerging, limited global presence	Highly dependent on imports; exploring domestic lithium	In its infancy; plans to build gigafactory	FAME and PLI programs, raw material partnerships	Limited; focused on cost-effective solutions	Fragmented supply chain, requires investment
Australia	Leading raw material supplier, weak in battery production	Largest global source of lithium; abundant cobalt, nickel reserves	Limited; focused on mining rather than production	Critical Minerals Strategy (2019), R&D funding, incentives for domestic processing	Investment in refining technology and new batteries	Lack of domestic processing capacity, export dependence

Recommendations

01

Policy and Regulatory Framework

Implement procurement programs that prioritize domestically produced battery components, ensuring market stability

02

Financial Incentives and Investment

introduce strong financial incentives to encourage investment in battery research and development

03

Supply Chain Development and Localization

Vietnam should develop domestic refining and processing capacity for key minerals, including nickel, cobalt, and lithium

04

Technological Innovation and Market Developmen

establish a national program and investment fund for strategic technology and industrial development including a state-backed knowledge-sharing platform to facilitate technology transfer and the commercialization of research findings

05

International Partnerships

Vietnam should prioritize the establishment and enhancement of international partnerships to strengthen its battery supply chain

06

Sustainability and Environmental Practices

Vietnam should enhance its policies and regulations related to battery recycling and the circular economy.

07

Workforce Development and Infrastructure Improvement

Vietnam should expand and modernize its logistics infrastructure, including rail networks, ports, and highways, to facilitate the efficient transport of raw materials and finished battery products.