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STRATEGIC INSIGHTS

Market Outlook: Electric Vehicles

January 2024

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Executive summary

Competition in the EV market and industrial policy – Asia	▪ Growth rate of global EV production to **exceed pre-pandemic levels**, led mainly by China ▪ China's industrial policies continue to support its EV industry, but foreign automakers will increasingly compete for **shrinking market share** in domestic market ▪ Sector consolidation and low domestic prices push Chinese firms to **expand into Southeast Asia and Europe**
Competition in the EV market and industrial policy – Europe and the US	▪ US EV industrial policy is focused on **growing the market** with incentives for firms, but excluding foreign made parts ▪ Although in attempting to decouple from Chinese automakers, these policies create substantial **upside for non-Chinese foreign automakers** ▪ Europe moving towards **protectionist measures** in light of China's EV dominance, but slow pace of progress drives member states to formulate own policy
Geopolitics of EVs	▪ Mining and refining of critical minerals and production of EV inputs are **heavily dependent on China**, increasing geopolitical risks in the sector ▪ Southeast Asia is an alternative for EV production and minerals but lower levels of GVC integration caps its progress ▪ Meanwhile, **localization of EV supply chains** is an emerging trend due to cost, safety concerns with battery shipping and supply chain risk

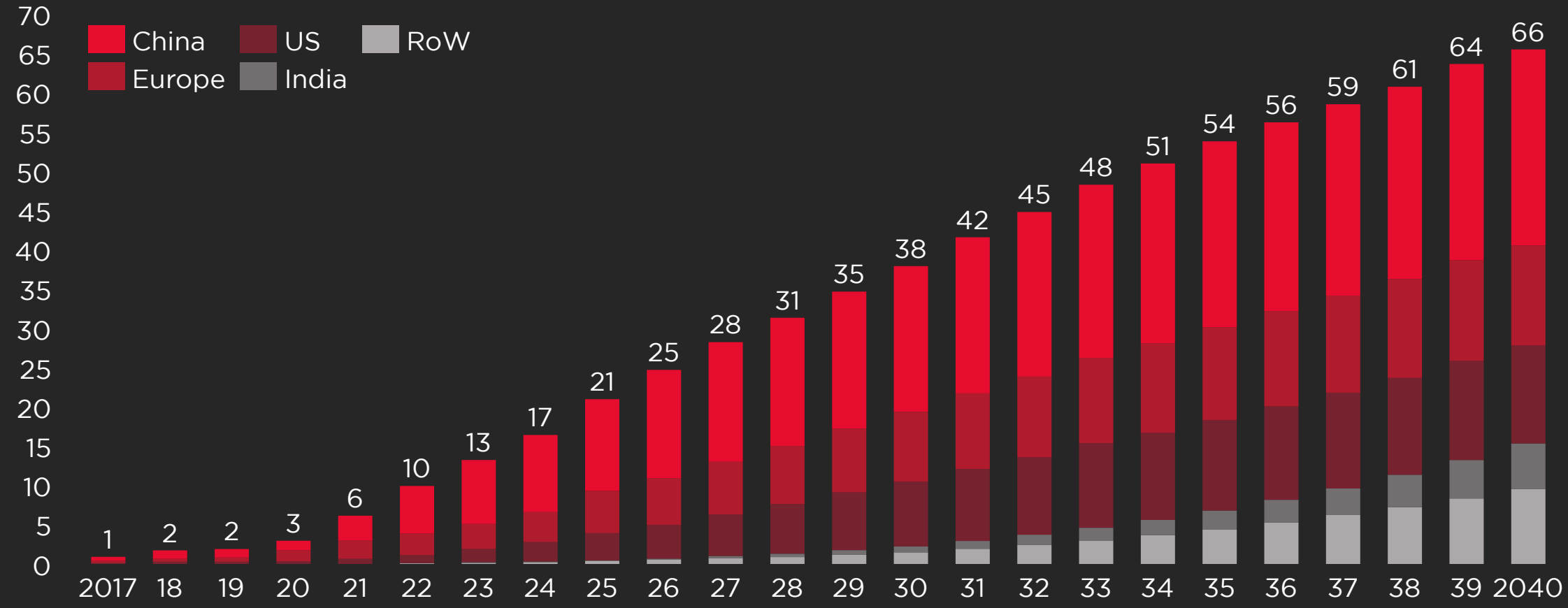
SECTION I

Competition in the EV market and industrial policy

Global EV production to recover from pandemic slump in 2023

Growth rate to exceed pre-pandemic levels

EV PRODUCTION OUTLOOK
MILLION VEHICLES



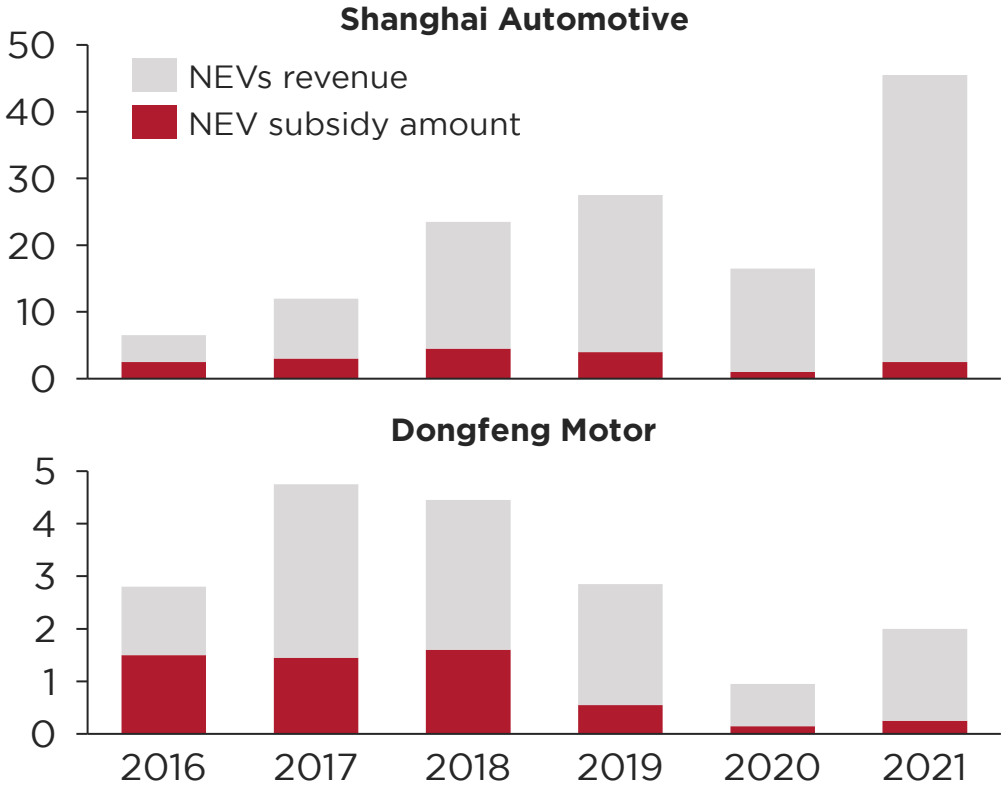
Source: Oxford Economics, Onyx

China's state support for EV sector to continue

Even as national purchase subsidies have stopped

Direct subsidies less important to EV firms in lead up to discontinuation in Jan 2023

SUBSIDY TO REVENUE RATIO FOR EV FIRMS
BILLION RMB



Source: Sixth Tone, China Briefing, Protocol, Onyx

Instead, support measures now focus on EV infrastructure and keeping firms financially strong

Type of support	Details	Expected end-date
Tax-related	$72B package of tax breaks for EV purchases	2027
EV infrastructure	Improve capacity of rural power grids to lower cost of charging	N/A
EV infrastructure	Build charging stations sufficient for 20M EVs; financial subsidies, favorable banking policies for charging station developers	2025
Local-level subsidies	14 provincial governments offering cash subsidies, shopping vouchers and cashback to EV buyers	Unknown
EV credits	EV companies sell regulatory NEV credits; NIO earned $18m in Q4 2020 selling credits	Unknown

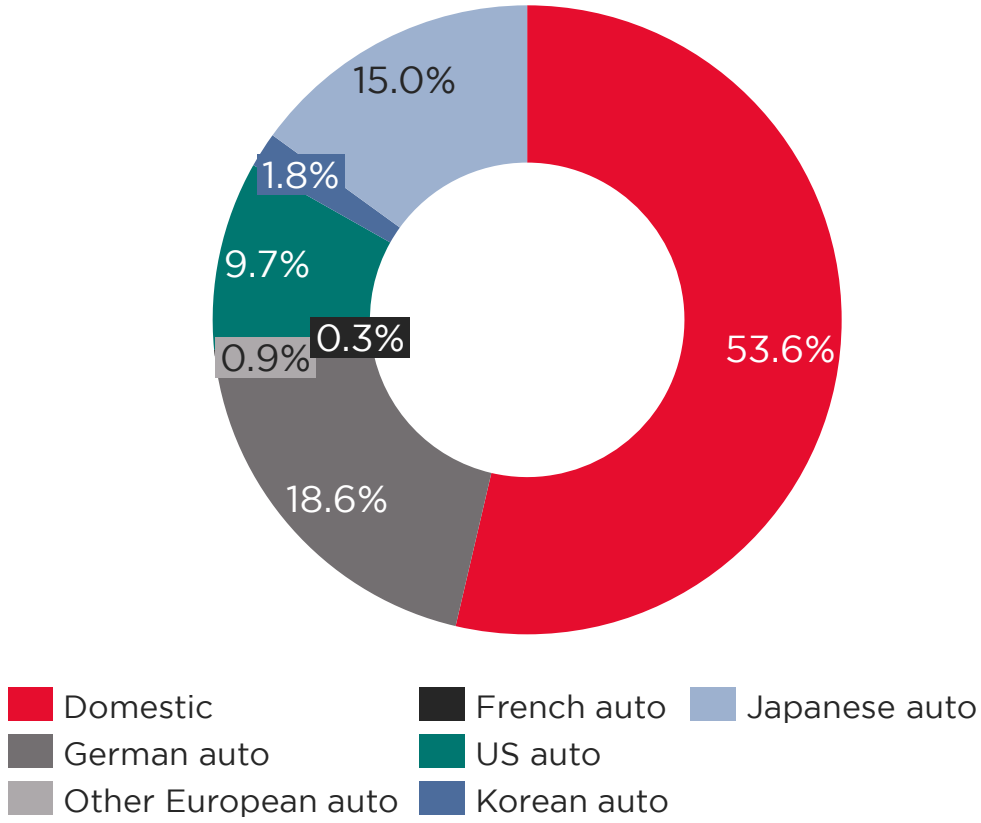
Last updated: July 2023

Foreign auto firms will struggle to maintain already low EV market share

Unsustainable prices and razor thin margins make this endeavor harder

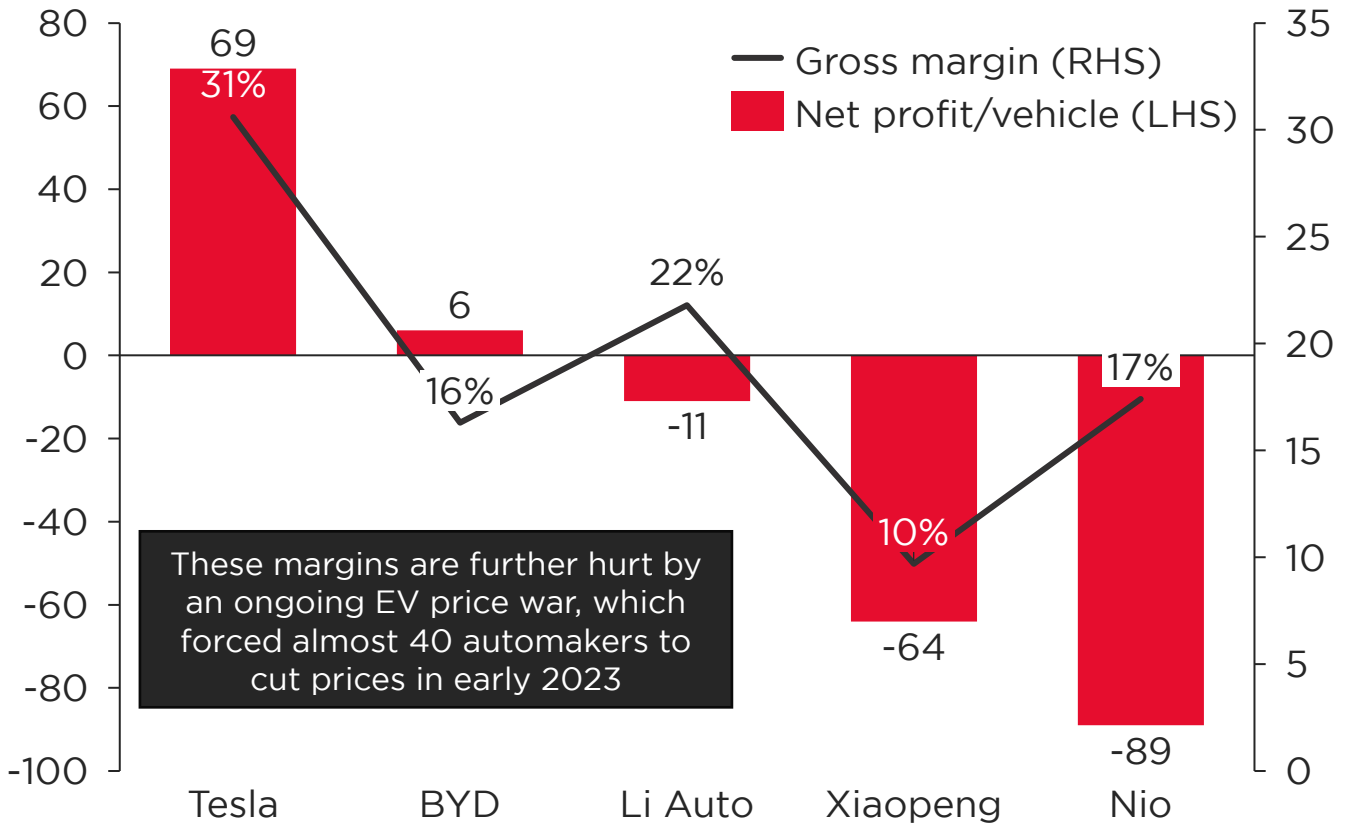
CHINA AUTO SALES MARKET SHARE IN JUN 2023

%



NET PROFIT PER VEHICLE AND AUTO BUSINESS GROSS MARGIN IN 2022

THOUSAND RMB (LHS), % (RHS)



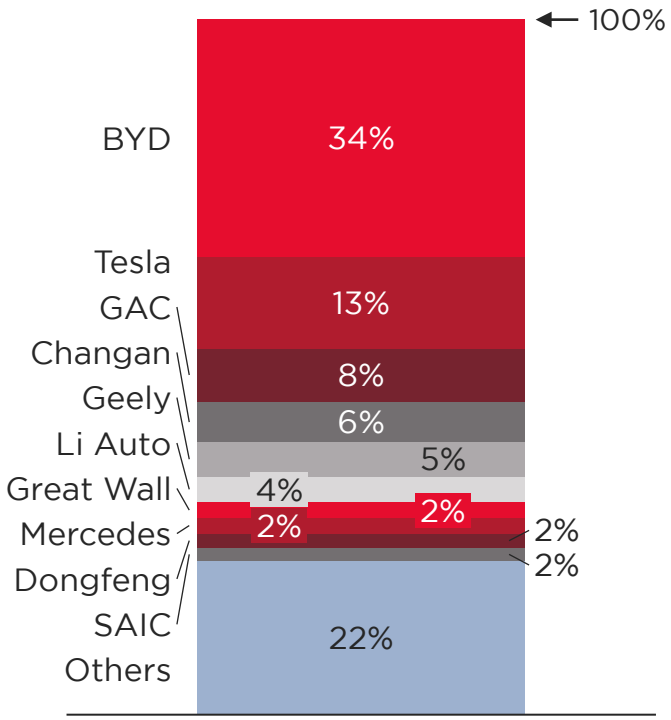
Source: CPCA, SixthTone, Onyx

And sector consolidation in China is ongoing

Meaning fewer, but more formidable Chinese players in the coming years

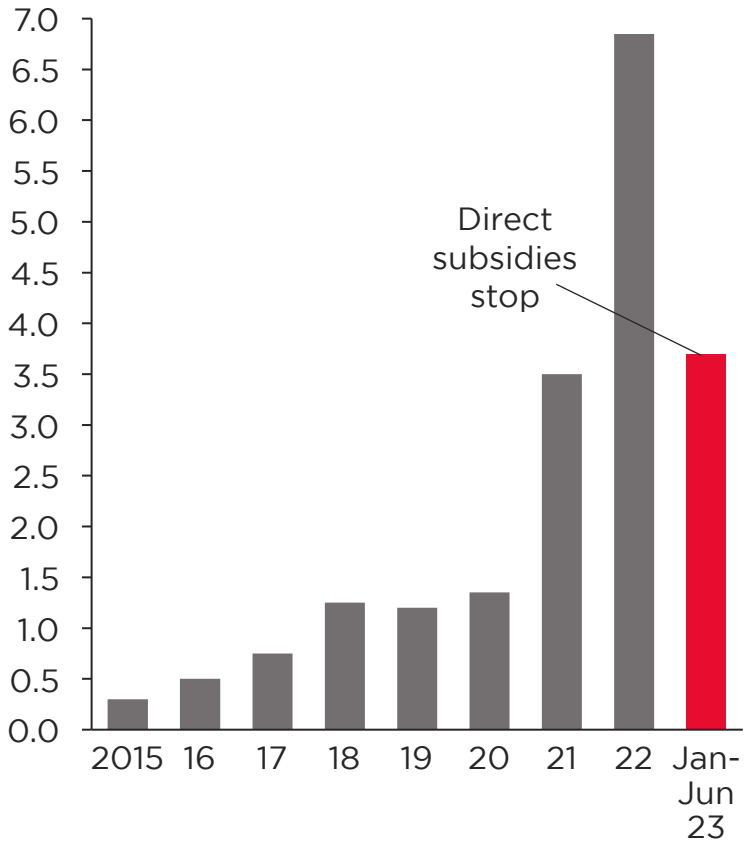
China's EV sector is still fragmented...

TOP AUTO GROUPS FOR EV SALES, MAR 2023
% MARKET SHARE



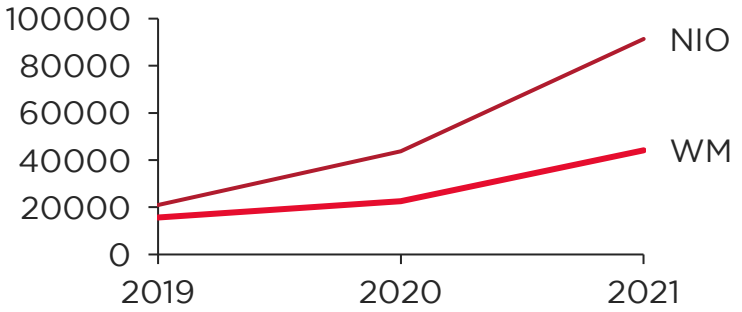
...meaning multiple firms are competing for less business...

NEV SALES IN CHINA
MILLION UNITS



...pushing out weaker players as market leaders gain

WM MOTOR VS NIO CAR SALES
NO. OF UNITS



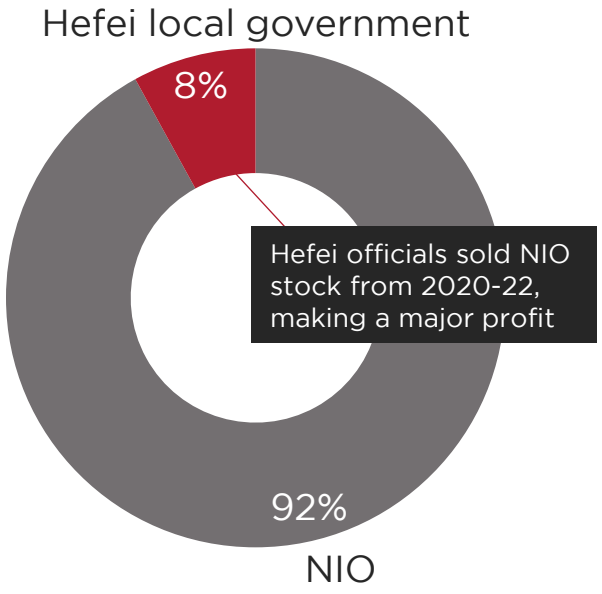
BYD, TESLA MARKET SHARE
%

Source: Nikkei Asia, SixthTone, Bloomberg

Pace of consolidation depends on local governments

But their ability to support provincial champions is wavering

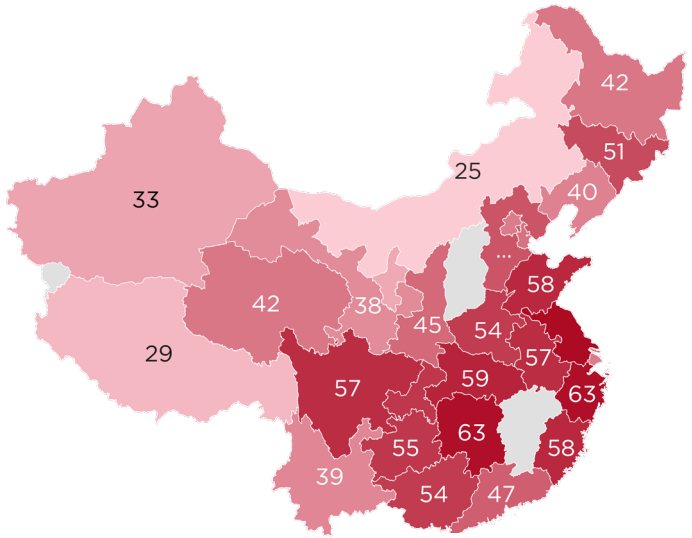
NIO SHAREHOLDERS, JUL 2022



- In early 2020, Hefei authorities rescued NIO from cash flow problems by securing a 24.1% stake.
- Xpeng Motors, Li Auto and WM Motor are similarly backed by state capital

LAND FISCAL DEPENDENCE RATIO

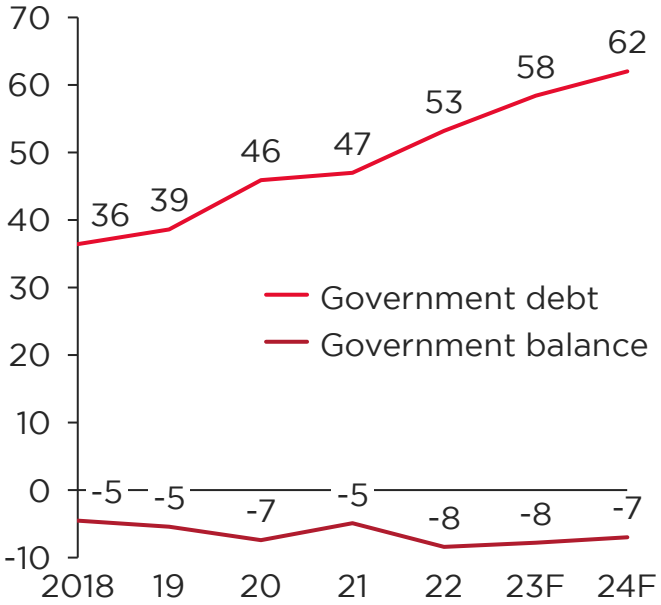
LAND SALES REVENUE % OF TOTAL FISCAL REVENUE



- On average, land sales revenue accounts for more than 40% of total fiscal revenue
- Continued decline in land sales will eat into local government budgets

GOVERNMENT DEBT & BALANCE

% OF GDP



- Local governments also struggle with mounting debt
- Subsidies and tax credits for EVs will exacerbate this burden

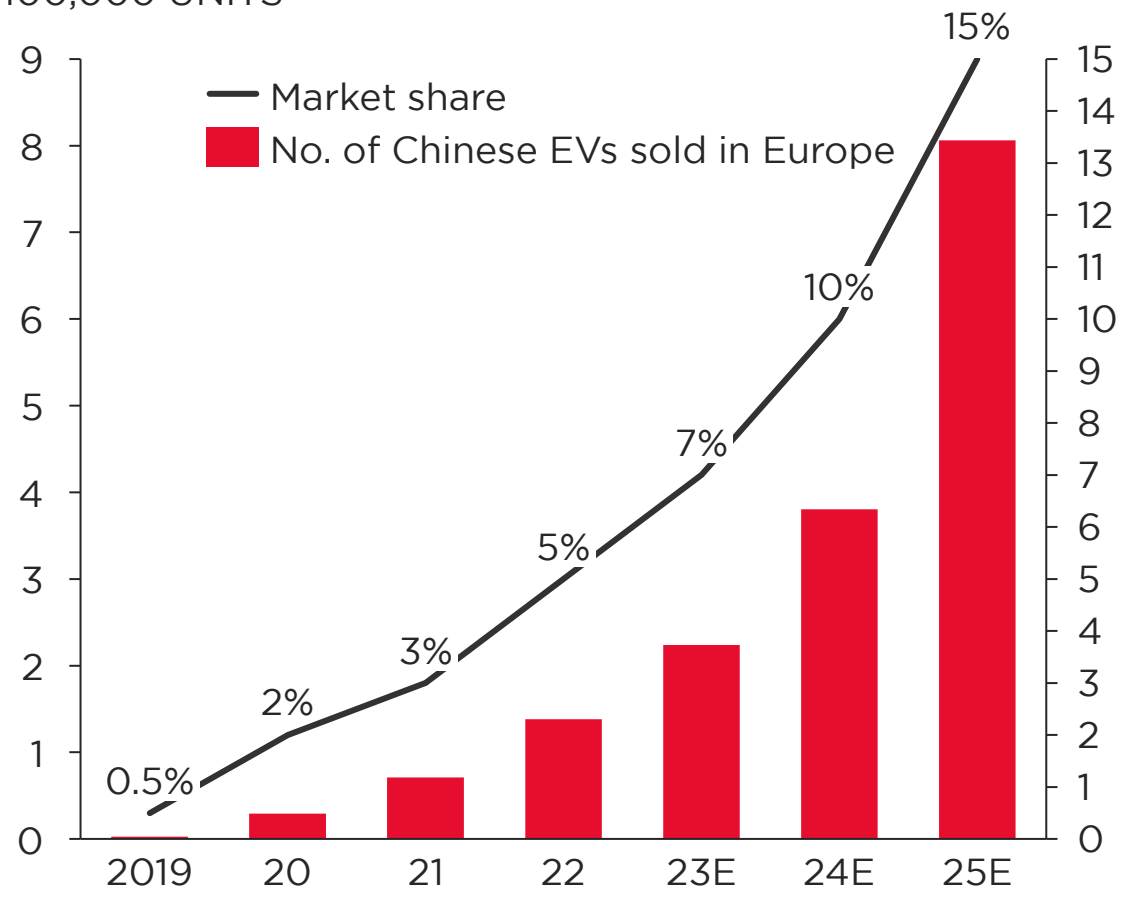
Source: Nikkei Asia, CNEVPost, PRC Ministry of Finance, Sina, Bloomberg, Oxford Economics, Onyx

Low domestic prices drive EV firms to expand globally

Southeast Asia and Europe are two key markets for Chinese firms

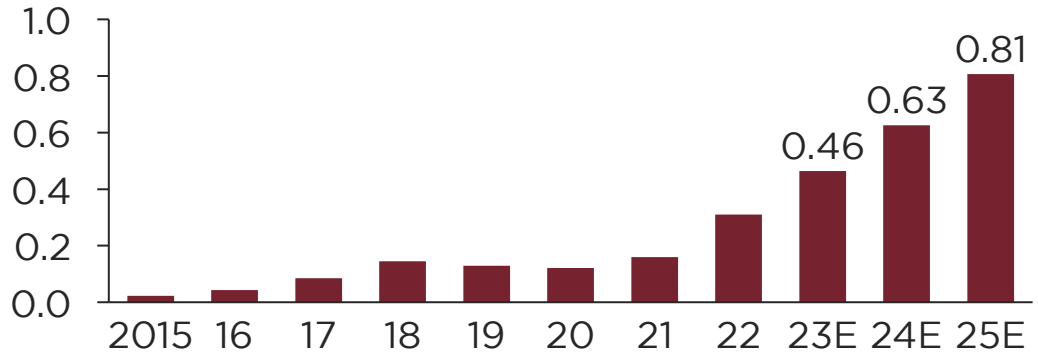
PROJECTED CHINESE AUTO OEM EV SALES IN EUROPE

100,000 UNITS



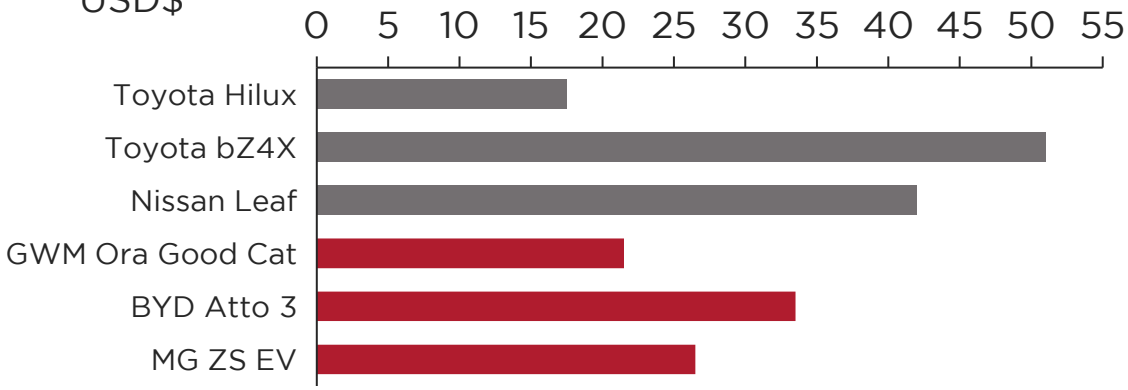
PROJECTED EV SALES IN SOUTHEAST ASIA

100,000 UNITS



PRICE OF JAPANESE EVS VERSUS CHINESE EVS

USD$



Japanese ICEs are currently dominant in Southeast Asia, but Chinese EVs are more affordable

Source: BloombergNEF, MacroPolo, KPMG, Forbes, Onyx

US policy focuses on growing the market

Major incentives exclude many foreign-made parts

Percentage of allowable components

Item	2023	2024	2025	2026	2027	2028	2029+
Critical minerals	40%	50%	60%	70%	80%	80%	80%
From US or FTA Partner + from 2025 zero percent requirement for minerals extracted, processed or recycled by a FEOC)							
Battery components	50%	60%	60%	70%	80%	90%	100%
Manufactured or assembled in North America + from 2024 zero components manufactured by a FEOC)							

- In 2024, EV credits granted in the Inflation Reduction Act will be constrained to only vehicles manufactured without components from a “foreign entity of concern” (FEOC); finalized list of guidance on key countries to be issued before EOY 2023
- Leasing of new vehicles exploits a gap in the restriction for consumers to claim tax credits without meeting domestic production requirements

Source: US Treasury Department, Stanford Institute for Economic Policy Research

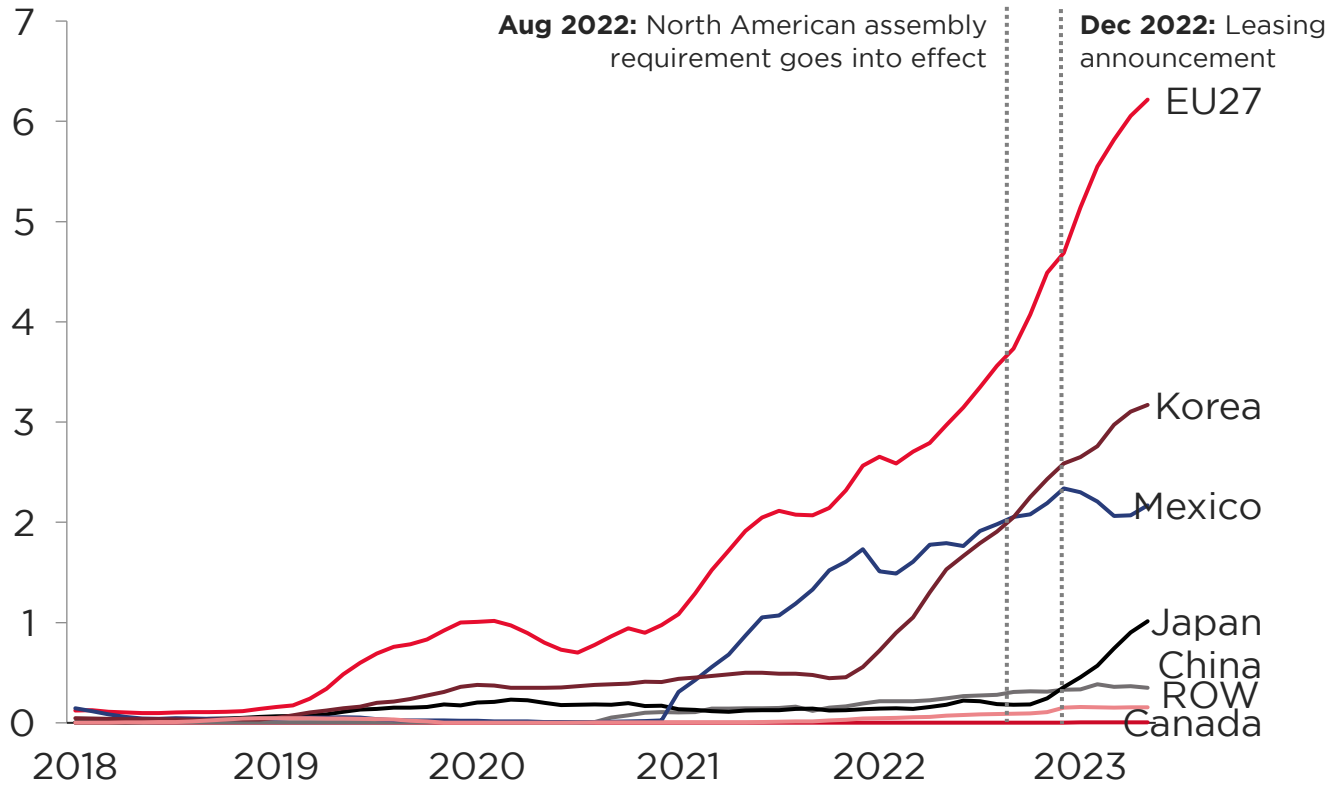
US efforts to reduce dependence on China creates substantial incentives for non-Chinese automakers

Through leasing as a workaround

Dec 2022	Delay in critical minerals/battery components regulations until Mar 23; leased vehicles eligible for tax credits
Mar 2022	FTA partners can gain access to tax credits; Japan qualifies by signing critical minerals agreement with the US

1. Vehicles leased do not have to comply with sourcing requirements; foreign autos are eligible
2. Countries aiming to sign critical mineral agreements with the US (Indonesia, Philippines, UK) will have access to credits if successful
3. More and more foreign leased EVs will compete with US-assembled autos, the latter which are subject to sourcing requirements that the former are not

US imports of electric vehicles by source
USD$ billion



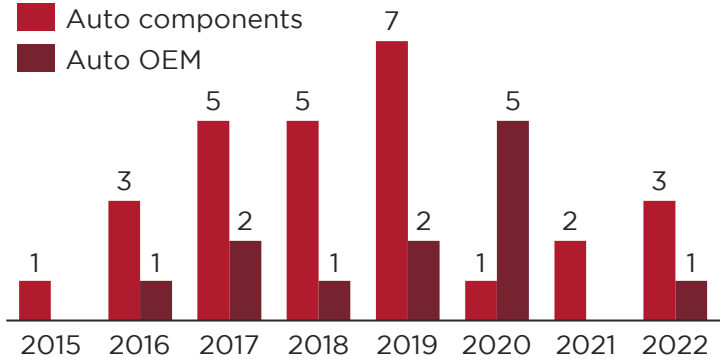
Source: Peterson Institute for International Economics, Onyx

But decoupling EV supply chains from China is difficult

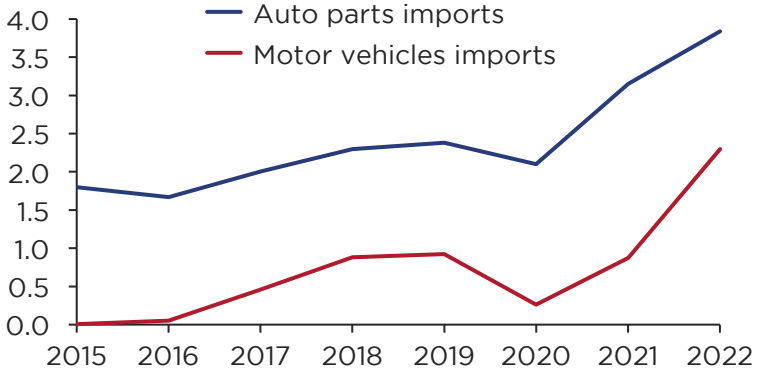
Given extensive Chinese investment in other countries

MEXICO

Chinese greenfield auto FDI into Mexico
No. of projects

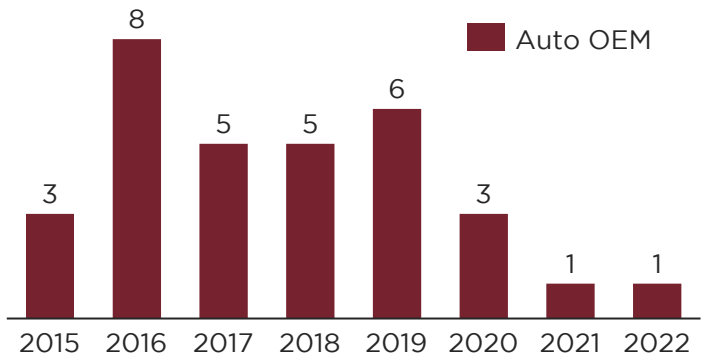


Mexico auto imports from China
USD$B

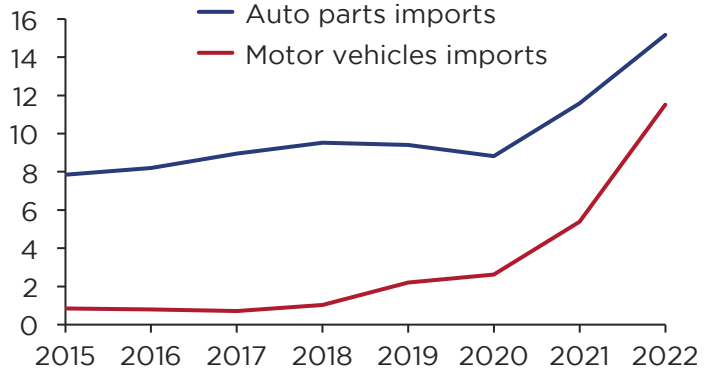


ASIA

Chinese greenfield auto FDI into Asia
No. of projects

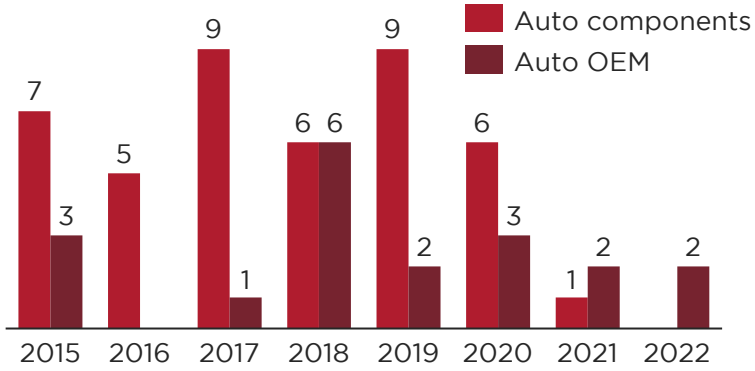


Asia auto imports from China
USD$B

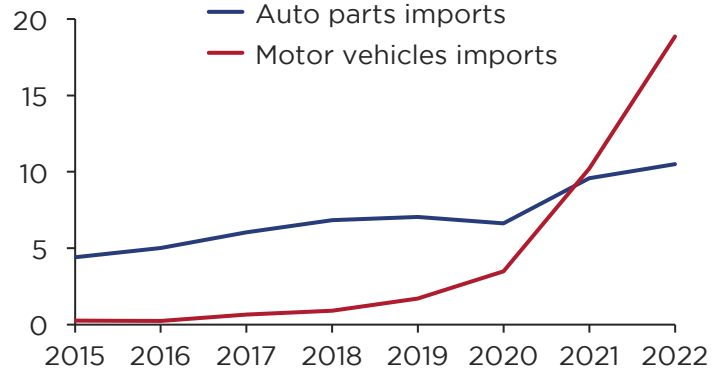


EUROPE

Chinese greenfield auto FDI into Europe
No. of projects



Asia auto imports from Europe
USD$B

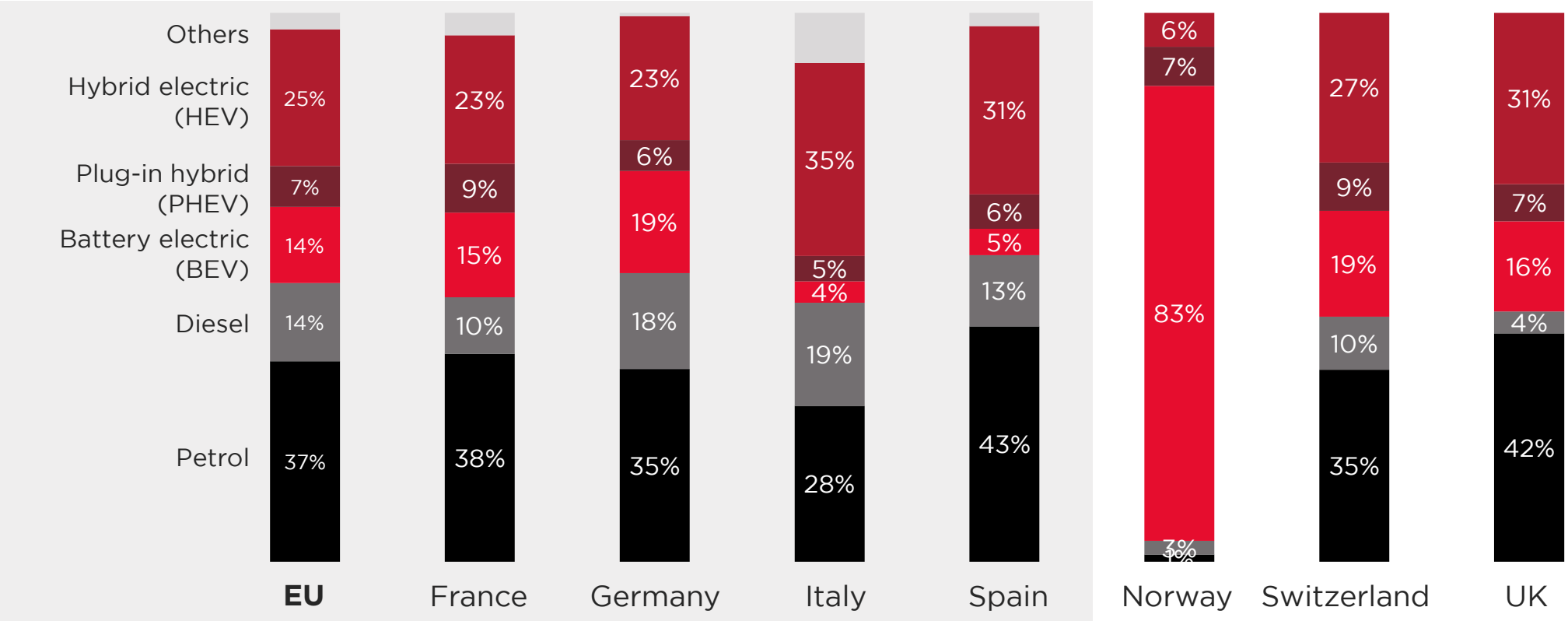


Source: fDi Insights, ITC Trade Map, Onyx

EVs are almost half the new passenger vehicle market

EV takeup varies across geographies due to national incentives and infrastructure; petrol registrations dropping rapidly

Europe: New passenger vehicle registrations by power source
% share, Jan-Aug 2023

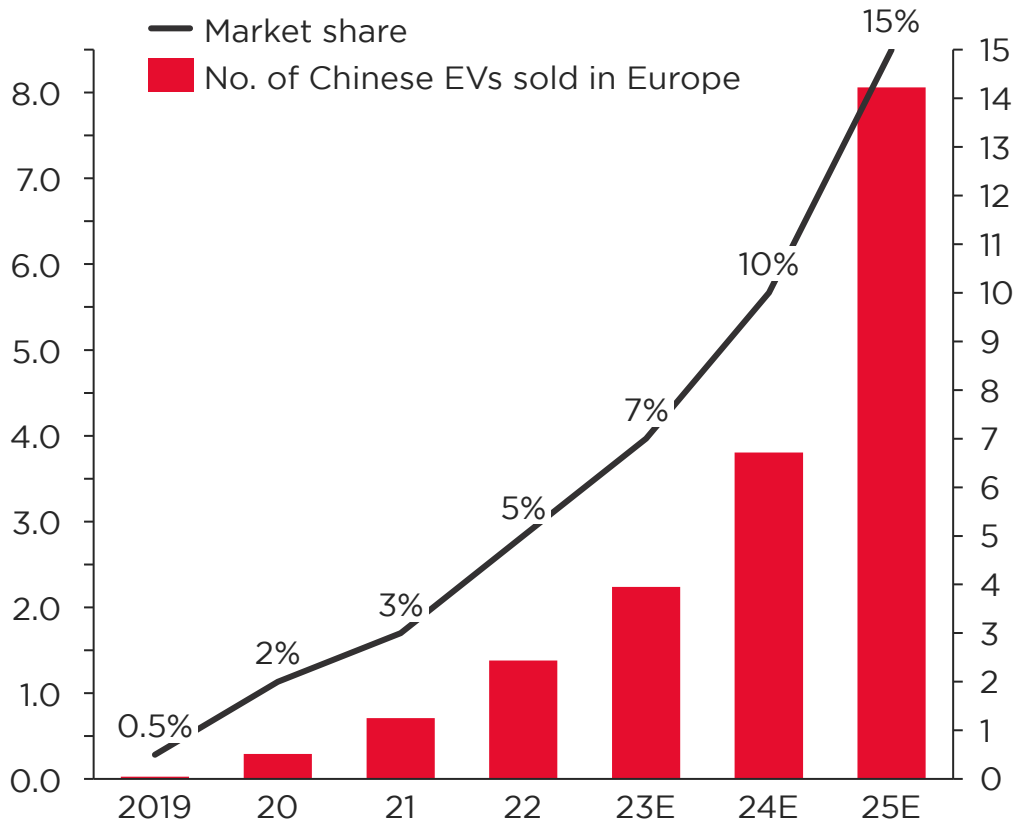


Source: Onyx, European Automobile Manufacturers' Association (ACEA)

China's EV dominance prompts protectionist moves

EU's slow response drives new industrial policy at member state level; emerging signs of EV backlash

Chinese auto OEM EV sales in Europe
100,000 units; % share



EU launches subsidy probe aimed at Chinese imports

- Commission launched an anti-subsidy investigation on October 4 into new battery-powered vehicles imported from China (by Chinese and other OEMs)
- Could result in tariffs of 25%+ on EVs from China as early as Q2 2024, but internal division and legal barriers could slow or reduce import restrictions

Member states pursue own initiatives

- Environmental import barriers are aimed at Chinese cars
- France: Existing consumer bonuses for purchases of EVs will be retargeted at EVs with a low environmental footprint from January; Asian imports will be most affected
- Italy: Likely to pursue a similar policy inspired by France's

Chinese clean energy import surge could slow EV transition amid broad sustainability backlash

- EU walked back 2035 ICE vehicle ban per member-state protests; wide opposition to Euro 7 proposal

Source:

SECTION II

Geopolitics of EV batteries

Reducing reliance on critical minerals is key for new battery technologies

Sodium-ion battery supply chains are least risky for US automakers

Criteria		Lithium-ion (LIB)	Sodium-ion (NIB)	Hydrogen fuel cell	Solid-state
Supply chain risks	Raw material cost	Volatile and high prices	NIB cathode material ~60% cheaper than LIB	Dependent on natural gas and coal prices	Same materials as LIB but with solid electrolytes
	Raw material availability	Concentrated in a few geos – Australia, Brazil, Zimbabwe, reliance on China for processing	Evenly distributed worldwide, plentiful mineral deposits	While widely available, production is difficult in water-stressed or fuel-short areas	Concentrated in a few geos – Australia, Brazil, Zimbabwe, reliance on China for processing
	Transport risk	Must be stored with min. charge, creating fire risks	Safer as transported at zero volt	Transport cost can be 3x production cost; highly flammable, prone to leaks	Lower risk of combustion compared to LIB
	Geopolitical risk	High – Chinese firms dominant in LIB supply chain from upstream to downstream	Medium – Chinese battery/EV firms lead in NIB tech, but supply is widely available	Low – production and supply not concentrated in any geo	Medium – East Asian battery makers lead in solid-state production and research
Timeframe for commercialization		Currently in use	Chinese firms to produce in 2023; NIB production can directly use existing LIB production lines	Transport difficulties, carbon-intensive production	NIO offered solid state batteries in its EVs in 2023; Toyota to manufacture them for EV use in 2027

Source: Wood and Mackenzie, IEA, Nikkei Asia, Onyx

Battery properties matter for range anxiety

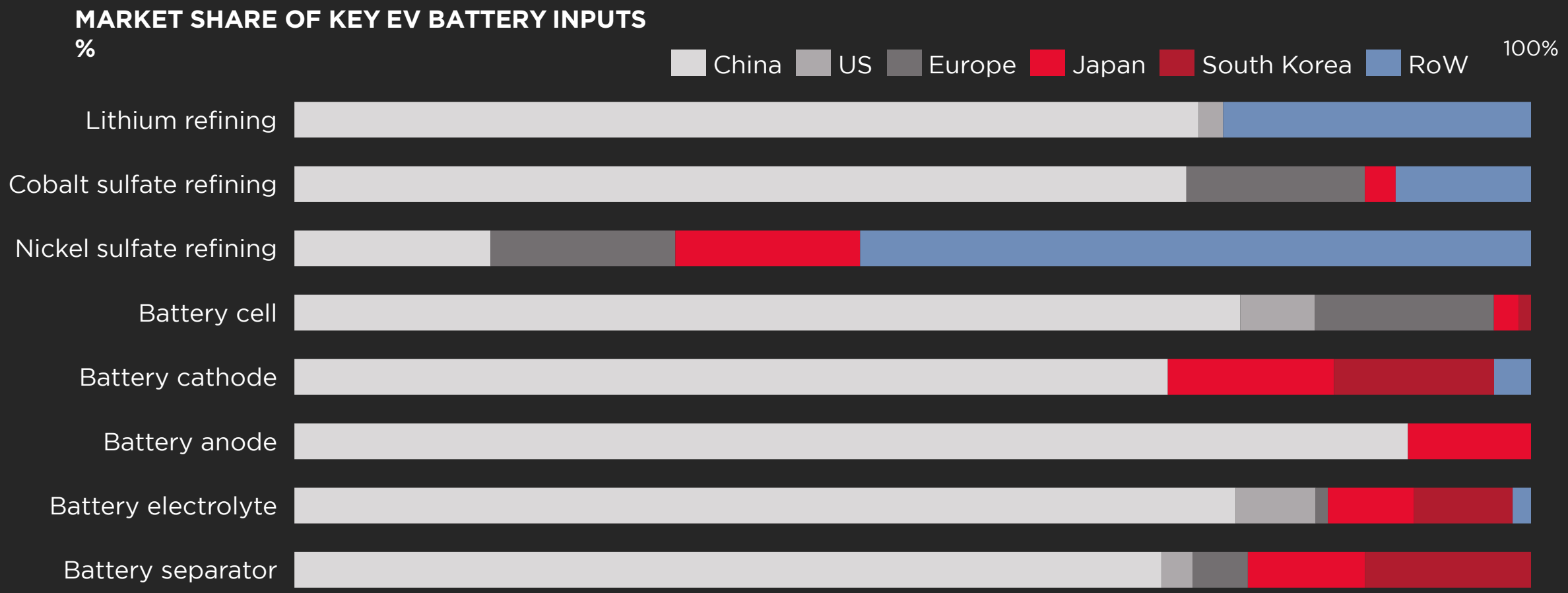
And consumer concerns around charging time

Criteria	Lithium-ion (LIB)	Sodium-ion (NIB)	Hydrogen fuel cell	Solid state
Energy density	200-300 Wh/kg	75–200 Wh/kg	Higher energy density than LIB; varying estimates	2-3x the energy density of LIB
Safety	Tend to overheat and can be damaged at high voltages	Performs in a wider operational temperature range	Flammability and electric shock risk	Low risk of fire, wider range of operational temperature
Lifecycle	1000 cycles	3000 cycles	Unknown	1000 cycles
Price	$151/kWh	$77/kWh	Varying estimates but more expensive than LIB	$80-90/kWh
Potential commercialization				
Segment	Currently used across multiple segments: light vehicles, buses and trucks	Lower density/range and cost suited for light/passenger vehicles	Longer range and higher cost more applicable for heavy duty trucks rather than passenger vehicles	High density and low cost makes it applicable across most segments like LIBs
Market	Varying levels of uptake in US, Europe and East Asia	Likely to pick up in emerging markets and/or densely populated regions with cost-conscious consumers	Suited for less densely populated markets, although availability of hydrogen fueling infrastructure a hurdle	Likely to mirror where LIB uptake is high

Source: Onyx

Production of EV inputs dominated by a handful of countries

China looms large in downstream EV supply chain

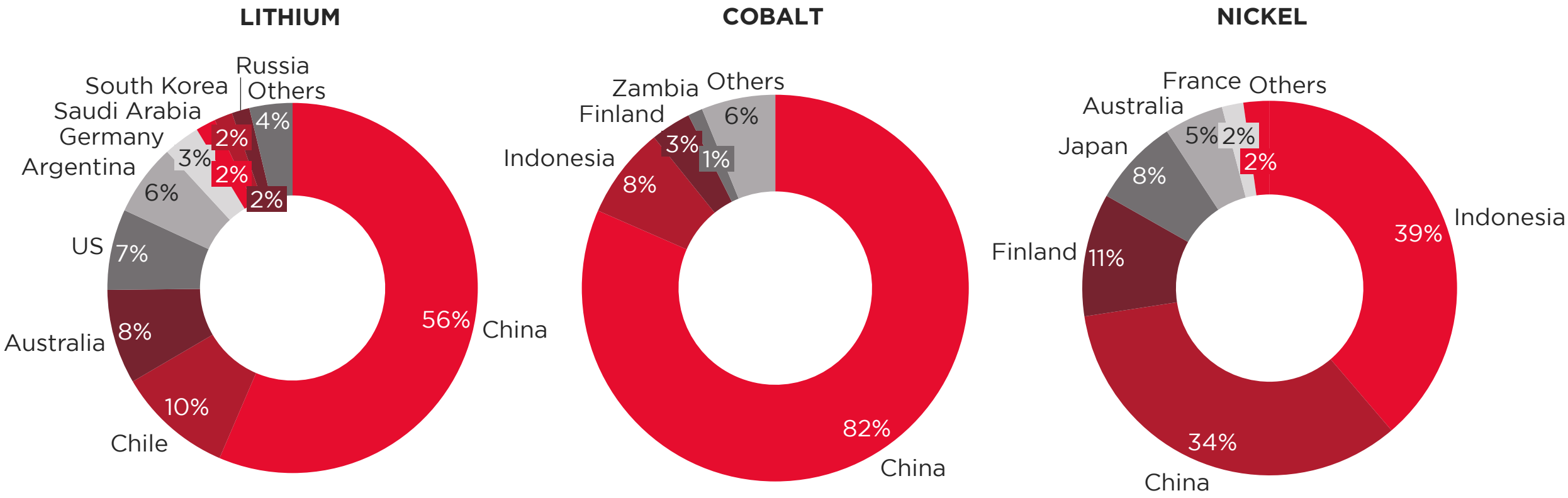


Source: FT, Onyx

China’s dominance in critical minerals will persist

Although other countries are poised to gain headway

PROCESSING CAPACITY IN 2025
THOUSAND TONNES/YEAR



Source: fDi Intelligence, Onyx

Response of Asian partners range from rivalry to close cooperation

Depending on the country's position in the EV supply chain

Position in EV supply chain	Level of value add		
	Low	**Medium**	**High**
Upstream	Indonesia Philippines		
Midstream			Japan Korea
Downstream where China is dominant		Thailand India	Japan Korea

Indonesia and the Philippines

- Countries with low value add in upstream sector like mining and some processing tend to integrate supply chains closer with China
- Receive Chinese FDI, JVs with Chinese EV firms with an eye to moving up value chain

Thailand and India

- Burgeoning EV producers with a strong ICE manufacturing base
- However, more investment is needed in other segments of the EV supply chain

Japan and South Korea

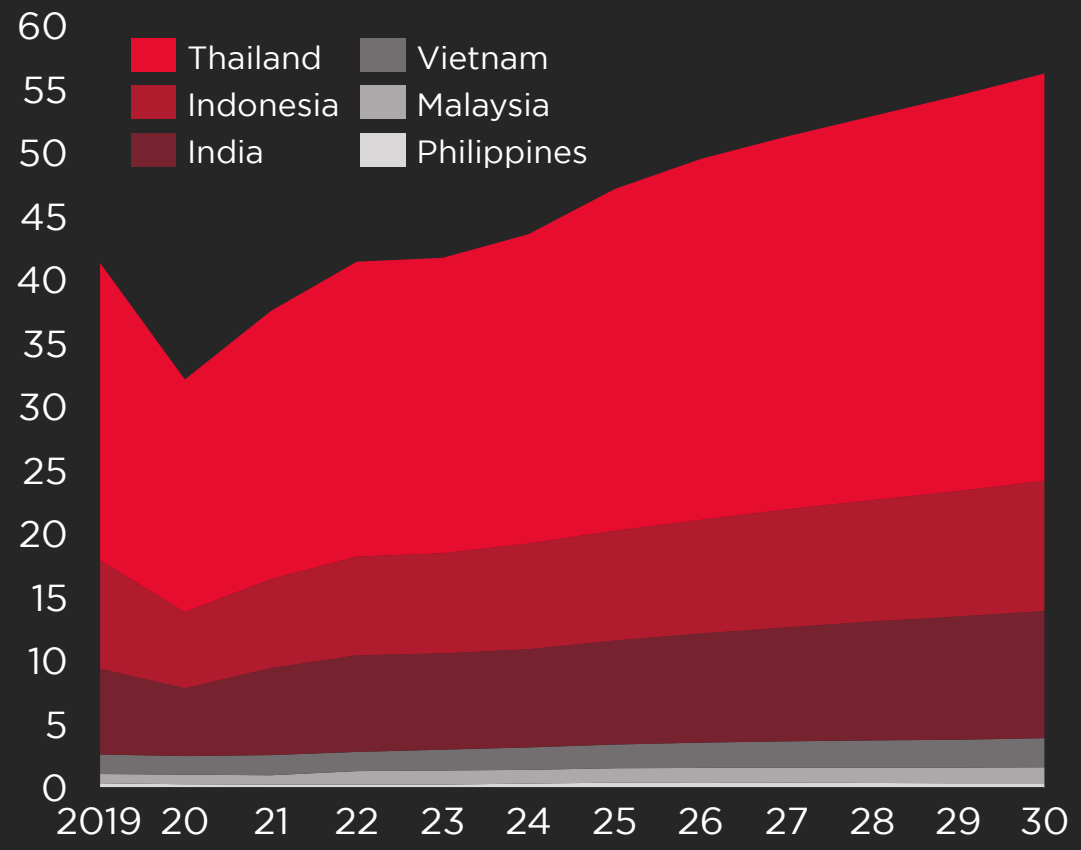
- Overlaps with China directly in midstream and downstream, i.e., battery and EV production
- Homegrown Japanese and Korean brands (Toyota, Hyundai etc.) compete for market share with Chinese firms globally

Source: Bloomberg, Onyx

TH and IN poised to be major EV producers

Due to strong ICE base and conducive policies for EV sector

VALUE ADDED OUTPUT MOTOR VEHICLES
USD$B, 2015 PRICES



MAPPING OF EV PRODUCTION IN ASIA

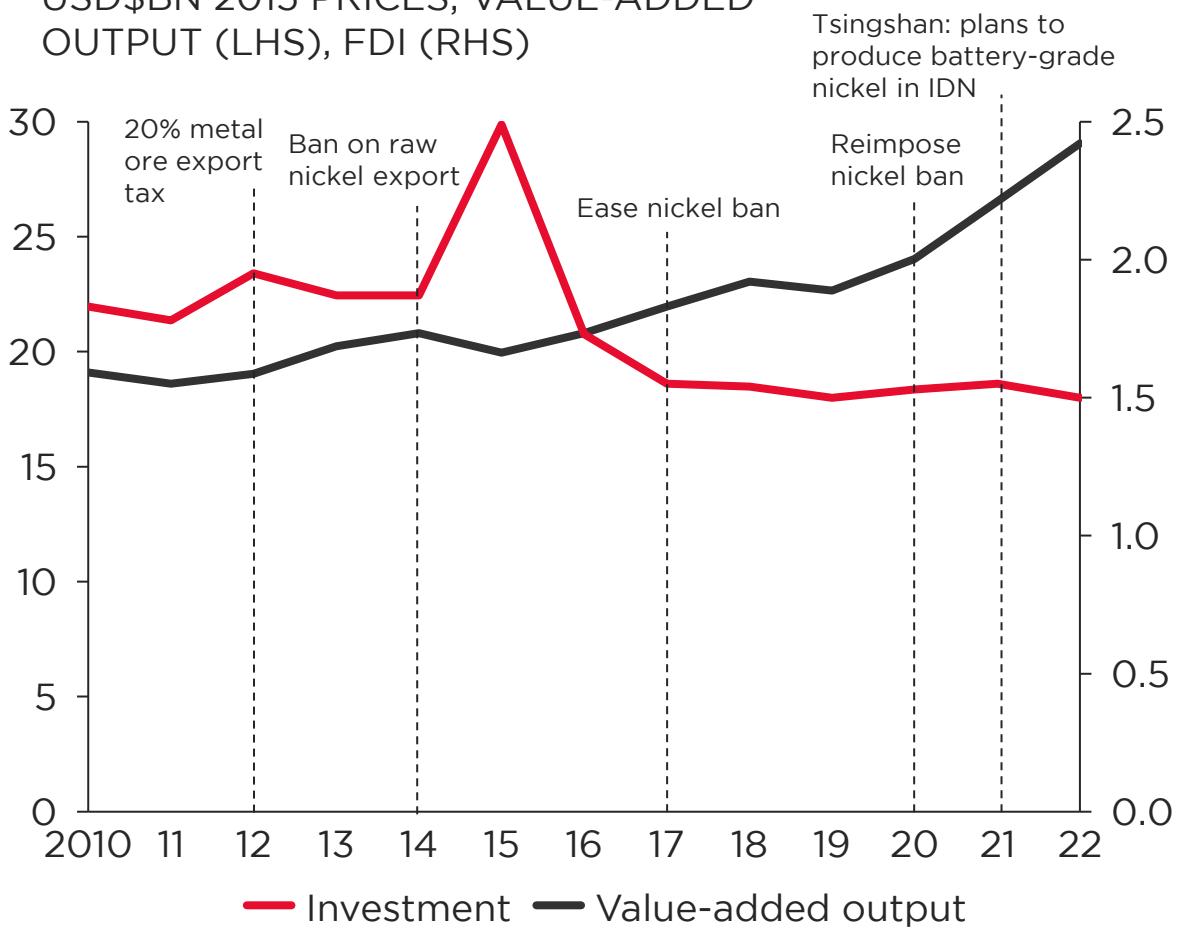
EV node	THA	IND	IDN	MYS	VNM
Minerals	No plans	Planned			
EV battery prod.	In prod				
Battery swapping					
Chips					
E-motorbikes					
HEVs					
PHEVs					
BEVs					
Battery recycling					
R&D					

Source: Oxford Economics, ISEAS, Onyx

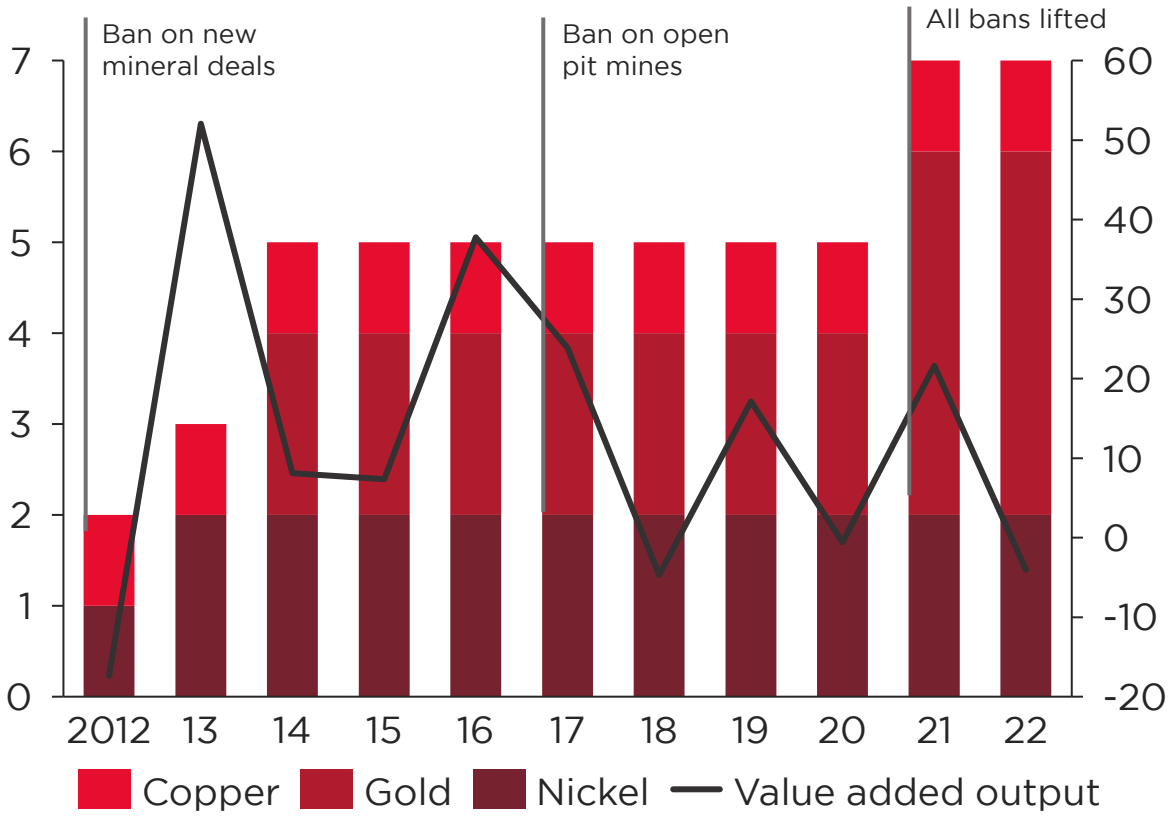
ID and PH attracts downstream investment through mining regulations

But this generates substantial policy uncertainty

IDN MINING AND QUARRYING SECTOR
USD$BN 2015 PRICES, VALUE-ADDED OUTPUT (LHS), FDI (RHS)



VALUE ADDED OUTPUT OF BASIC METALS AND NO. OF SMELTERS IN PH
NO. OF SMELTERS (LHS), % YOY GROWTH (RHS)



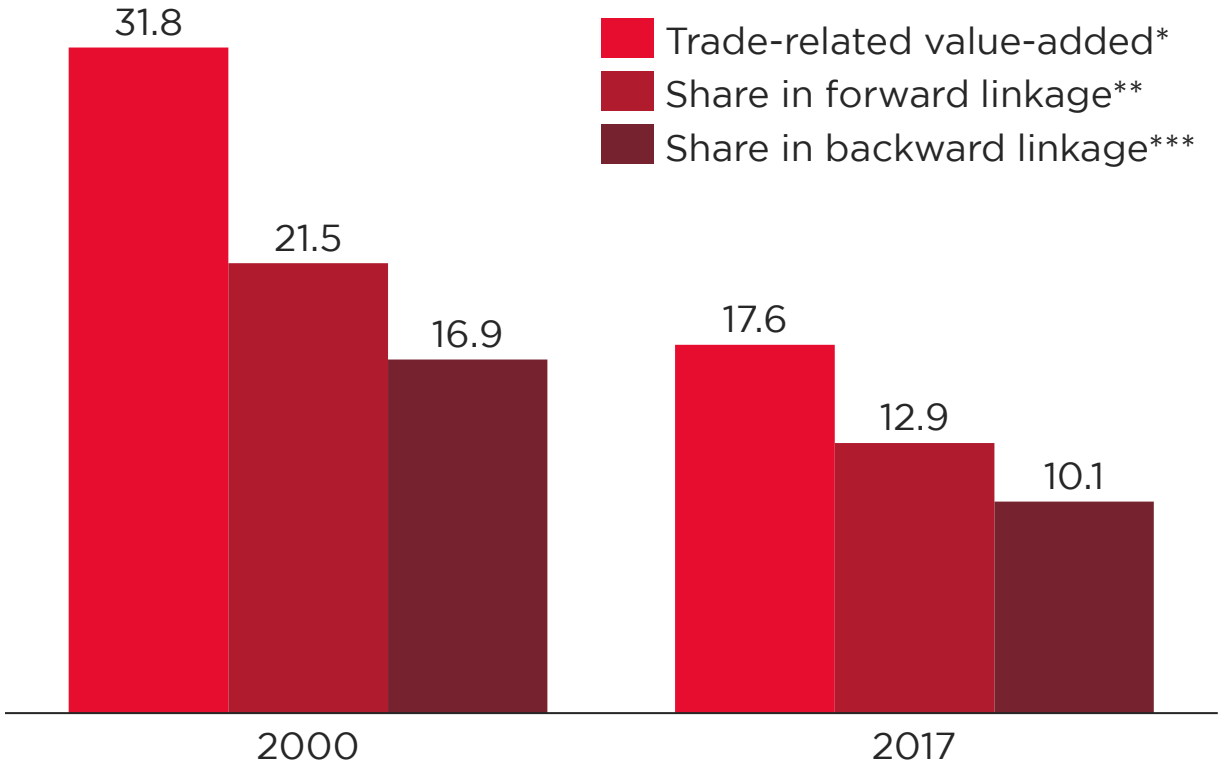
Source: Philippines Statistics Authority, Oxford Economics, Onyx

Further progress is capped by lower levels of GVC integration

And policy hurdles in doing business

INDONESIA'S PARTICIPATION IN GVCS

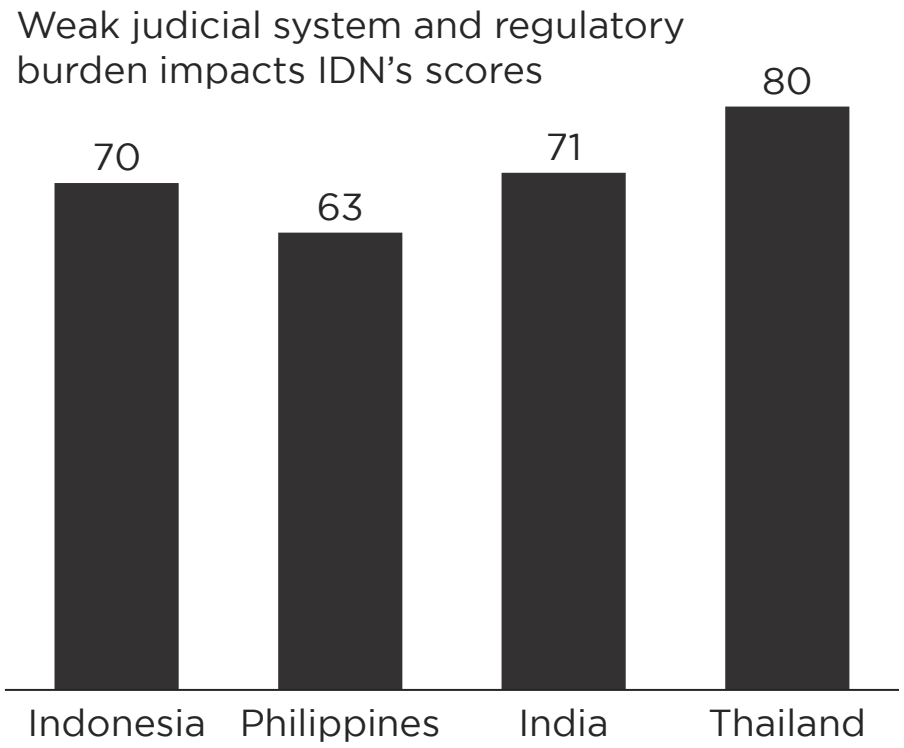
%



* Trade-related value-added as a share of total value-added
**Forward linkage – domestic value-added embodied in foreign exports (upstreamness)
***Backward linkage – foreign value-added in domestic exports (downstreamness)

EASE OF DOING BUSINESS INDEX

0 (LOWEST) – 100 (BEST)



Source: Asian Development Bank, Kezjar, Velic, Damijan (2022), World Bank

Strong vertical integration in JP and KR's EV industries makes them strong competitors

Conglomerate structure facilitates vertical integration

These conglomerates tend to have subsidiaries that range across the EV supply chain, allowing EV manufacturers to collaborate easily with battery makers, chip producers, and miners.

RAW MATERIAL MINING

Korean battery materials processing firms sign supply deals with miners such as Lionstown and Glencore, but do not mine themselves

SUMITOMO METAL MINING CO., LTD.

JX Nippon Mining & Metals

Directly involved in metals mining, production and recycling

MATERIAL PROCESSING

POSCO FUTURE M

LG Chem

SK on

Iwatani Corporation

LOTTE CHEMICAL

BATTERY CELL MANUFACTURING

SK on

SAMSUNG SDI

LG Energy Solution

L&F Co., Ltd.

EcoPro

Panasonic

TOSHIBA

EV MANUFACTURING

HYUNDAI

KIA

NISSAN

HONDA

TOYOTA

*This is not an exhaustive list

Source:: Various media outlets, Onyx

Localization of battery manufacturing a key trend

Due to cost, safety concerns with battery shipping and supply chain risk

Lithium-ion battery shipping hazards

Fire flammable liquids in LIB	**Explosion** flammable gases in confined space	**Thermal runway** uncontrollable and self-heating state	**Toxic gases** released from other hazards

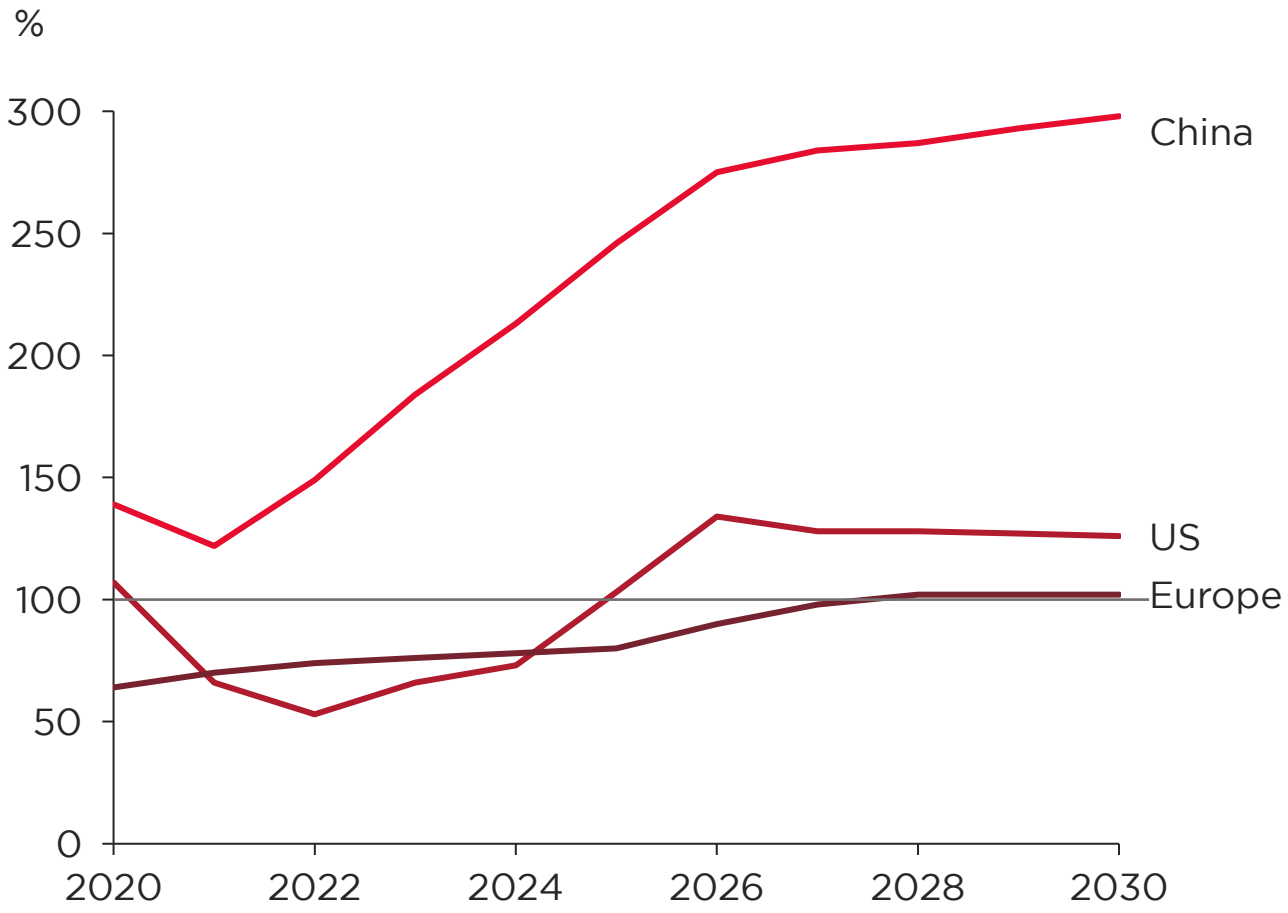
Creating additional shipping costs such as:

- Investment in containment systems that can withstand a lithium battery fire
- Increased compliance costs for airlines, handling agents, integrators and freight forwarders

Jun-23: Freemantle Highway Ship

- Cargo ship with ~3000 autos caught on fire off the Dutch coast
- Authorities said fire was hard to extinguish possibly because it began near an electric car
- International Maritime Org. to evaluate new safety measures for shipping EVs

SELF-SUFFICIENCY OF EV BATTERY MANUFACTURING CAPACITY



Source: ICHACA, Reuters, Goldman Sachs Onyx

Get in touch

Website

onyxsi.com

Contact

info@onyxsi.com

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